AGRICULTURAL ENGINEERING

Published by the American Society of Agricultural Engineers

Headquarters of the Society: Saint Joseph, Michigan

Ralph U. Blasingame, *President* — Raymond Olney, *Secretary-Treasurer*

Volume 17 — JULY, 1936 — Number 7

CONTENTS

Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cent a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .

AGRICULTURAL ENGINEERING

VOL 17, NO 7 EDITORIALS JULY 1936

Air-Conditioning in Agriculture

MOST of the members of the American Society of Agricultural Engineers who traversed the plains from Chicago to Estes Park by rail made occasion to comment with gratitude on the change since the previous pilgrimage to an annual meeting so far west. Nature's dispensation of weather had something to do with it, but the major change was air-conditioning of railway cars. And most of those who mentioned it seemed to regard air-conditioning as a contribution to their comfort by other branches of engineering. Such, of course, it is in the popular or newspaper sense.

But if air-conditioning be broadly and basicly defined as regulation of atmospheres, with complete control of temperature and humidity and partial control of chemical content and suspended solids, it appears that air-conditioning was a part of the day's work for agricultural engineers well in advance of its debut as a means for human comfort in its present sense. To be sure, our contributions to air-conditioning have been specialized and fragmentary, but they are pieces in the pattern.

We called it dairy barn ventilation, but no case of air-conditioning has presented such a problem of economic and physical limits. So far as occurs to us, none but the agricultural engineer has undertaken to set a low limit on temperature, a high limit on humidity, and effective control of contaminant gases with only biological sources of heat and energy—all under conditions of maximum exposure and minimum structural expenditure.

As leaders by at least a decade in the routine cleaning of intake air for internal-combustion engines, our tractor engineers tested and exploited every physical principle which has proven practical for removal of dust in air-conditioning as now popularly known. Whether it be soft corn, combined wheat, sweet potatoes, or eggs, our achievements in crop curing and storage have been essentially regulation of temperature and humidity in the gaseous medium. So also is forage drying, even when the atmosphere consists of the products of combustion and its temperature goes up to 1500 degrees Fahrenheit.

If we have been backward anywhere in the application of air-conditioning, it is to the environment of the farmer and his family. We make bold to suggest that this become a more important objective of our farm home engineers. Surely no one better deserves relief from the humid heat of corn-growing nights than the farmer who has blistered by day as the sun flames over the cornfield. Modern machinery has emancipated women and children from the cornfield (and the other fields as well), but it remains for us to mitigate the climatic extremes that impinge on the farm home.

Technical development of air-conditioning equipment has reached the point where this is practical. Electric energy, ever more widely available at ever lower cost, should make it economic. The American farmer, due in part to agricultural engineering assistance, furnishes abundant food at low cost for all his fellow Americans, including the alleged ten million unemployed. Surely it is not too much to ask of allied industries, of distribution and of finance, that they find ways to put part of those ten million at work creating the means for air-conditioning the American farm home.

Between the Farmer's Mailbox and His Wagon Box

LOST, somewhere between the farmer's mailbox and his wagon box, a wealth of scientific information and educational effort!

A wide disparity between the scientific knowledge and improved equipment and practices available to agriculture, and the extent to which they are applied by farmers, has been noted repeatedly. L. F. Livingston cited it again, and forcefully, in his presidential address to the American Society of Agricultural Engineers at its annual meeting in Colorado last month.

He pictured the extent and fine work of federal and state research and educational set-ups for the benefit of agriculture. He acknowledged the thousands of farmers availing themselves of one or more of these services. He envisioned a future need of still greater knowledge on the part of farmers, and then he said, "That brings us to still another serious weakness in our existing agriculture, the lack of knowledge of modern methods that pervades not a few but millions who are seeking a livelihood from the soil. The situation is bad as it is now, but it will be progressively worse if effective education is not a part, and a major part, of any program for the improvement of agriculture through scientific research."

Lazy and first-glance thinking offhandedly ascribes this failure to utilize available help to a general apathy of farmers to their own welfare. But Livingston scotches that argument in one of the many available ways with brief remarks as the results of N. A. Kessler's work on engineering reorganization of farms for the USDA Bureau of Agricultural Engineering. Livingston says of these results: "Among 108 farms of the better type it failed to find one that could not reduce its costs by making changes within the owner's means."

Here is evidence that even the most intelligent, well-trained and progressive farmers need more than to have knowledge of new and better methods arrive in their mailboxes. They need specific personal help in applying new knowledge to their individual farm programs.

The individual farmer has a dawn-to-dusk schedule of necessary routine production and marketing operations. He is in a poor position to assemble, review, compare, analyze, evaluate, and select certain facts and principles from the

wealth of new scientific information; and interpret them into changes in his work for tomorrow, next week, or next year with assurance that they will produce extra net dollars or satisfaction from the maze of soil, weather, market, equipment, financial, neighborhood, family, individual, and other variables that make up the special situation with which he has to deal.

Here apparently is a limiting factor in the effectiveness of agricultural education. It has the constrictive characteristics of a bottle neck in the program of agricultural progress. It suggests that many farmers are too close to their forest of problems to see anything but the trees. It suggests that many farmers still need the initial experience and inspiration of applying with their own hands, under expert guidance on their own farms, scientific knowledge to produce increased profit and satisfaction. It suggests that education of farmers will be most effective when it reaches farmers thoroughly imbued with the viewpoint of Kettering's philosophy of continual dissatisfaction, search, and change for the better. And it suggests that agricultural research and education, to show greater results in the farmer's harvest wagon box, must be carried beyond his mailbox. He needs more help to apply its generalizations to his very individual situation.

For an example of a type of agricultural education that does find its way into application, we refer again to Kessler's research and incidental extension work on "The Engineering Reorganization of Farms." (See AGRICULTURAL ENGINEERING for April 1936.) In it, education "follows through" to the individual farm, goes over its problems with the farmer, helps the farmer to understand his special situation, works out with him a program of improvement within reach of his pocketbook, puts applicable scientific facts into the "what and how" of daily work on the farm in question, and checks net profit at the market wagon. It is not entirely an engineering project; it calls for the best possible advice from all branches of agricultural science, and injects as much as possible of this knowledge into daily practices.

To give this personal service to a large number of farmers would be an ambitious program. But the need of some such step is implied by the lag between what can be done, as shown by science, and what is being done by most farmers. And it offers the pleasant prospect of a growing body of farmers actively interested in self-improvement as farmers, strongly backed by a system of applied science and education that effectively reaches and meets their needs, fearlessly meeting the weatherman, the tax collector, mortgage sharks, and foreign competition.

Running Water Runs Too Slowly

IF DEPENDABLE data were available, it probably would show that agricultural America consumes a greater gallonage of gasoline than of bath-water. It can be estimated with considerable confidence that this is true of at least eighty per cent of our farm population; not as individuals, of course, but en masse. As agricultural engineers concerned no less with living standards and human values than with production processes we may search for causes and cures of this condition. As apostles of plenty our efforts will be not to reduce the one, but to enlarge the other.

Taken as a symbol of running water, plumbing in general, and sanitary sewage disposal, the bath tub is far older than the motor car, taking it also as symbolic of gasoline consumers. Among the non-rural population the bath tub is more firmly entrenched, more nearly in universal use, than the motor car. How, then, did the motor car outrun the rural bath tub? Why does gasoline flow more freely than water on the farm?

In some measure agricultural engineers are to blame. We have put more pressure behind the gasoline than the water. Yet there has been no lack of extension effort in behalf of running water, septic tanks, and home comforts generally. Gasoline commanded increasing attention because it was succeeding, while the plumbing projects were comparatively discouraging because of their meager results. We simply applied more effort where effort was more fruitful.

Nor is this state of affairs due to lack of purchasing power. A typical farm family expends in motor car depreciation in five years a sum sufficient to equip the farm home completely with plumbing good for twenty years, including water supply and sewage disposal. We must look further for the fundamental reason for the discrepancy. We can appraise the influence of habit, custom, city ordinances, availability of public mains, and still lack adequate basis for the backwardness of the rural bath tub.

Though it discounts our pride in the influence of our profession, we believe the main difference is one of commercial cooperation—the means and methods of merchandising whereby our missionary efforts have (or have not) been followed up. Nothing need be said as to the aggressiveness with which motor cars are sold. Trucks and tractors have plenty of sales pressure behind them. No such general, sustained pressure has been put behind running water.

It may be argued that plumbing involves problems of installation and service. The tractor and motor car involve greater problems of service, and those problems have been solved. The problem of installation remains, but it may be said in passing that the buyer of car or tractor does not buy wheels here, engine there, radiator and ignition somewhere else, and then rely on a local mechanic to assemble them. He buys—no, he is sold—a complete unit, including extras or options, from a single source with an undivided responsibility behind it.

Gasoline-consuming equipment has plenty of need for mechanics, but the manufacturers thereof do not rely for distribution on mechanics. And because it is sold by merchandisers it affords far more employment to mechanics than if distribution were in their hands. Perhaps it is because they were unincumbered by tradition and an entrenched craft, but the makers of motor vehicles organized their distribution with a clear concept of the temperamental difference between a merchant and a mechanic.

One more pertinent fact may be adduced. From the evolution of the tractor industry it appeared that, in distribution, knowledge of internal-combustion engine technology was far less significant than familiarity with farmers and farming. We wonder whether contemplation of these facts might lead to acceleration of the rural bath tub.

Agricultural Engineering Marches On

By L. F. Livingston

THIS is a presidential year. In the weeks to come the great political parties will lay their cases before the country, and with a renewed eloquence they will appeal to the farmer. It is not for me, in this closing week of my term as the chief officer of this body, to offer you any choice between parties, platforms, or candidates. As engineers dedicated to the service of all agriculture, we are not in politics. Regardless of who occupies the White House or of what laws are on the statute books, our work goes on, just as the farmer's work goes on of plowing, sowing and tilling his land, of harvesting and marketing his crops, and then of starting the cycle all over again for the crops of next year.

L. F. LIVINGSTON

It is necessary that, as engineers, we keep this fact in mind. Amid the blare of the bands, the oratory of microphone and stump, and partisan appeals to passion, it is not only important, it is mandatory that we become neither confused nor misled. Laws, honestly written and sincerely administered, may alleviate some agricultural ills; politics may give some measure of relief in emergency; broad and long-visioned statesmanship may make the farm road smoother for those who follow us, but when all is said and done that politics and statecraft can say or do, the final solution of our so-called farm problem will rest with one man alone—the farmer himself on his own farm.

The day-in and day-out job of farming is one of the homely problems that do not make resounding planks in political platforms. It is not easy to wax eloquent over the proper use of manure, over ridding potato plants of bugs, or the respective merits of tractors and mules, but it is with such things that the farmer must deal intelligently before he can hope to be successful in his calling. Talk of exportable surpluses if you will, of reciprocal tariffs, and the intricacies of international economics, but let us not lose sight of the fact that a simple and accurate bookkeeping system on every farm would probably contribute more to a lasting prosperity in these United States than the most Solomon-like legislation on any of these matters.

With us here today are the editors of two of the nation's great national farm magazines. I have no stock in either of these publications, but I seriously believe that if every farmer would spend a minimum of two hours a week in a conscientious study of either one of them, or for that matter of any good farm magazine, within a decade our farm problem would vanish into thin air. Perhaps I am old-fashioned and behind the times in my thinking, but I cannot bring myself to believe that this nation is so out of gear as some of our political friends would have us think, and that only a political miracle man can save our farmers from peonage. I believe that our farmers can and will, in the course of the orderly working of our established economic system, do all the "saving of agriculture" that is needed. More than that, I believe that agriculture under its own power, as our primary producer of raw materials, is destined for an era of development that will make its most golden past look drab.

There is work to be done, of course, and much of it is going to be work of the hardest and most difficult sort. There are complex problems to be solved that will tax the best brains we can muster. But that work has to do with the land, with the business of farming itself, and the problems are in the fields of science and engineering, of producing and selling, and of reproducing and reselling. In these fields politics is a novice. It will pay us, therefore, at this annual assembly, to take stock of the needs of agriculture stripped of all political bias, to map out our own platform of action that will point the way regardless of what party may win. Equally important, we should take stock of our agricultural assets, including the men and equipment and capital already in the front line, elbow to elbow with our farmers in their fight to make the American farm a better place to live.

Almost anybody, although he may not know a harrow from a hay rake, can tell you nowadays what is wrong with agriculture. Personally, I am an agricultural engineer and giving my working life to that profession because I believe there is more right with agriculture than there is wrong, because in this greatest of all industries I see wholesome opportunity and infinite promise, because I have faith in what agriculture is and confidence in its future. You, too, I believe, are agricultural engineers for the same reasons. If not, you are in the wrong job.

Figures may be dry or they may tell an inspiring story, according to one's interest. To me it is inspiring to know that the average farm family owns property valued at \$9,668 as compared to \$8,709 for the average town or city family, that even when the going was hardest only 40 per cent of our farms were mortgaged and only 20 per cent of those mortgaged farms, or eight per cent of all farms, failed to meet their interest charges.

I know, and you know, that agriculture as a vocation offers about the same opportunities for success as any other vocation. We have farmers whose incomes are easily comparable with the salaries paid the executives of leading industrial corporations, and I am speaking now of men who are paid from \$50,000 to \$100,000 per year. Actual figures are not available, but I believe investigation would show the percentage of farmers earning \$5,000 a year or better is substantially higher than the percentage of industrial workers earning \$5,000 or better. Industry's percentage of men in this earning class is less than one per cent.

If you will chart the gross farm income and the indus-

Annual address of the president of the American Society of Agricultural Engineers before the 30th annual meeting of the Society at Estes Park, Colo., June 22, 1936.

Author: Manager, Agricultural Extension Section, E. I. du Pont de Nemours & Company. Mem. ASAE. (President ASAE, 1935-36)

trial payroll since 1923, you will find that the farmer has had the advantage in almost ten years out of twelve, irrespective of benefit payments. According to recently announced findings, the agricultural equity in land and buildings amounts to 75 per cent. Compare this with 43 per cent for the average equity of urban real estate owners, with 45 per cent for public utility stockholders' equity in land and equipment, and with 51 per cent for railroad stockholders' equity in their properties.

True, agriculture has its slums, its ne'er-do-wells and its poorly paid, but so does industry, so do the professions, so does education, the church, the retail trade. Life is a risk wherever and under whatever name it is lived. A wind storm in Iowa may wipe out a corn crop, but one across a mahogany desk of industry may wipe out a thousand jobs, and often his job is the city man's all. There is no boss in the land big enough to "fire" the farmer who owns his farm.

These facts are agriculture's assets. We know them, but the trouble is that most of the nation does not. We who know have sat in silence while alarmists have spread the notion that all farmers are poverty-stricken, that farming is a profitless pursuit young men who hope to get somewhere in the world had better avoid. Today, the contrary of this is true. Agriculture rapidly is becoming an applied science that challenges the best talent youth has to offer.

Second in the list of agriculture's assets is the traditional resourcefulness and courage of the American farmer himself. Time and again in the past century, agriculture has faced crises fully as severe as the most recent one, and each time it has won through by using the same weapons, namely, technical improvements applied by farmers themselves on their own farms. Broad scale mechanization, the development and wide use of low-cost commercial fertilizers, improvements in the quality of stock and crops, and, following the World War, the rapid spread of cooperative marketing have been the practical and effective remedies that have routed one after another agricultural depressions. By technical betterment, unit costs have been cut repeatedly and a vanishing profit margin restored. Again contrary to popular notion, here is an industry that does not fear change but which in the past has blazed the trail of change. It can do it again, and will, and leading the onward march should be and, I am confident, will be the agricultural engineer.

AGRICULTURE'S EDUCATIONAL AND RESEARCH FOUNDATION

Third, we have built up in this country for the aid of agriculture what is without question the largest and most comprehensive system of scientific experiment and education that any industry can boast. At the top is the United States Department of Agriculture, one of the most important branches of our government. Fifteen general officers and seventeen bureau chiefs at an average salary of $7600 per year are needed to administer its complex activities. This is more than the Departments of Commerce and Labor have combined. The federal department of agriculture has available for distribution, free or at cost of printing, authoritative bulletins on every conceivable phase of farming. Its experts are constantly exploring the world for new things. It cooperates with state-operated experiment stations in every state for studies of specific local problems. This vast service organization stands at the command of the humblest farmer.

It is pertinent to consider briefly the highly personalized sort of assistance given farmers by just one agency of the Department — the Bureau of Agricultural Engineering. Quoting at random from the latest annual report of the Bureau, one finds that during the year nearly 17,000 farmers were aided in procuring better types of machines and using equipment more efficiently. Over 18,000 were trained in adjustment and repair work on nearly 30,000 machines; 31,000 were given expert help in planning 36,000 new buildings, and on 24,000 farms in improving or remodeling old buildings originally designed for the needs of animal power days and poorly adapted to modern purposes.

FURTHER UNIT COST REDUCTION WITHIN EASY REACH OF MOST FARMERS

Along with a variety of major research projects ranging from soil erosion control to the development of seed treating and insect-fighting equipment, the Bureau made intimate studies of individual farms over seven states, a work that is still in progress. *Among 108 farms of the better type it failed to find one that could not reduce its costs by making changes within the owner's means.* In other words, in this single, relatively small agency of government has been accumulated enough hard facts on farm betterment, which, if they could be made generally applicable, would substantially narrow the gap between agricultural depression and prosperity for some millions of farm owners.

Next in order to the federal agencies we have the state agricultural agencies, the agricultural colleges and experiment stations, and a national network of demonstration and experimental farms. Finally, we have the county agricultural agents, who are within telephone or post card call of every farmer. From one or another of these publicly maintained sources the farmer can, theoretically at will and usually at no cost, obtain the best advice that is to be had on any subject he may name, from planning a 1,000-acre crop program to ridding his hens of lice. No other industry under the sun, no other occupation, no other individual worker has such an abundance of expert aid at call, and on the whole it is efficient aid, administered by conscientious and capable men who professionally are neither Republicans nor Democrats.

Additional to these public agencies are the farm cooperatives, which each year grow in strength; a farm press that blankets every district; and the agricultural agents of corporations, such as the railroads and manufacturers of farm materials, or of manufacturers who buy farm products for raw materials. These forces in themselves constitute a most formidable organization. No other industry has anything that is comparable.

And this is not all. Agriculture's fourth great asset and ally is Business, in which I include the research laboratories of our largest corporations, the genius of their scientists, inventors and managers, and the capital that is back of them. Moreover, the strength of this alliance lies in the fact that it is based on self-interest, not on airy altruism. The present-day trend of industrial science is very definitely toward the wider use in manufacturing of organic raw materials grown on the farm.

It is not necessary before an audience of this character to go into detail on what has become known as the farm chemurgic movement. However, there has been some misunderstanding of what this movement represents. It is not as some think, a recently conceived cure-all for farm ills. For a half century and longer organic chemistry has been actively interested in the conversion of farm crops to industrial use. The first rayon filament was announced in 1889. Dynamite and smokeless powder, both chemical developments of the 19th century, go to the farm for basic materials. "Duco" finishes, which began a revolution in the

paint industry in 1923, are in the final analysis made out of cotton, corn, and air. The Farm Chemurgic Council was organized at Dearborn, Michigan, less than two years ago. At that time one-tenth of the corn crop already had as its market the factory, while the value of cotton seeds, once a waste, represented one-eighth of the total return of the cotton grower. Other examples are too numerous to mention.

I do not point to the very recent origin of the Farm Chemurgic Council disparagingly. On the contrary, I wish to make clear the solid foundation on which the movement is built. We already have the scientists and the means of training more—in buildings and equipment for the training of chemists our schools and colleges alone have invested more than 300 millions of dollars since the World War. We have the laboratories, the precedents of past accomplishment, and, most important of all, we have leaders who clearly appreciate that manufacturing industry's stake in this development is fully as big as the farmers'.

Sum up these assets of agriculture—its superior investment in property, its proven ability to meet its obligations, its resourcefulness in improving its methods that has made the American farm workers the most productive in the world; its unparallelel facilities for scientific research, experiment, and education that are publicly maintained; its alliance with the most progressive units of manufacturing industry, as well as an aroused public consciousness that the farmer must prosper if anybody is to prosper—add these together, block in the glowing picture they present, and well may we rise, somewhat flabbergasted, to ask, "Then what does agriculture *lack?*"

Perhaps its greatest need is an appreciation of its own strategic position at a time when all of the world's work is

OPPORTUNITIES FOR FARMERS TO LOWER COSTS PER UNIT PRODUCED RANGE FROM SIMPLE REARRANGEMENTS OF FENCES AND FIELDS TO SUBSTANTIAL INVESTMENTS IN LABOR AND QUALITY SAVING BUILDINGS AND EQUIPMENT AS FACTORS IN A PLANNED PRODUCTION PROGRAM

undergoing change. We are passing from an essentially mechanical into an essentially scientific period of development. New standards are being set up, new methods become obsolete almost before they are tried, and nothing in industry is so insecure as the practice that is rooted in tradition. It is only to be expected that an industry so basic as agriculture, which might almost be called the nation's economic pulse, would be among the first to be shaken by this transition. Also, possessing the assets I have named, agriculture should logically be among the first to become reestablished in the coming new order. Read your history and you will find that it was the farmer who led the way in the American machine revolution. It was a threshing machine engine that started Henry Ford, a farm boy, to thinking about his first horseless carriage when Detroit was little more than a straggling town.

Agriculture needs a change in its psychology. It needs to rebuild its confidence in the future. For a decade and a half we have been systematically discouraging farmers by a propaganda that insists success in farming can begin only in Washington. We have been telling the farmer that he is beaten before his plow turns a furrow, that the world he feeds and clothes is united in conspiracy against him, and that if one bogey doesn't get him another will. The wonder is that our farmers as one man have not quit work long ago and resigned themselves to an inevitable fate. Indeed, countless of them in effect have done this, and today, to their own detriment, see hope only in laws and bonuses. In the meantime, pests riddle their orchards, disease that was sown with the seed thins their wheat, storms take toll of their rich topsoil, and their unpainted buildings rot and their machinery rusts. These are not properly the problems of government at all, but of the individual farmer. Moreover, they are problems that can be readily solved.

Another deterrent to improvement is the tenant farmer system. In 1890, only 28 per cent of our farms were worked by tenants. That percentage since has been rising closer and closer to one-half of the total—in 1930, it was less than seven points short of that mark. The usual lease offers no incentive to the tenant to better the property, no opportunity to become its owner, and the result is only what might be expected with the vast majority of our more than 2,600,000 tenant farmers. Owner-management is the strength, and it should be the objective of our agriculture. The most effective way to increase owner-management, it seems to me, is to stop painting the prospects of farming so black that youth is frightened into other careers.

The fact is that today agriculture presents a challenge to youth to come and conquer. At no time in its long history has it held brighter promises for the young man of courage, initiative, industry, and brains. I repeat, we are entering a chemical age that is turning industry's eyes toward the farm as the potential major source of its raw materials. At the same time discoveries in the medical sciences are giving to food, both as a preventive and curative of disease, an importance undreamed only a decade or two ago. The plant grower of tomorrow may well rank with the physician as one of the vital factors in bettering and maintaining the public health. The records of research under way in our agricultural experiment stations and elsewhere in every part of the civilized world indicate the trend.

Already we can substitute on a crude basis twenty-five per cent of soybean oil for linseed oil in paints. But here and there we come upon a batch of soybean oil that is good enough to permit a one hundred per cent substitution—why,

nobody now knows. Working with X-ray and ultraviolet light, new factors in such research, scientists hope to get the answer to this riddle, and when they do, there seems to be every reason to believe that plant breeders will be able to produce a variety of soybean that will consistently yield oil as good or better than linseed.

We are going to produce plants to order. Rapid development of the X-ray technique and the mounting knowledge of genes and chromosomes foreshadow the time when the manufacturer will specify the physical or chemical property he desires in his raw material, and the plant breeder will create a plant that has it. Just to prove that it could be done, some time ago a breeder crossed two totally unrelated plants. Superficially regarded, the result was a monstrosity of no practical use, but actually it was proof to the scientific world that man's skill in the field of plant breeding has reached a point where the most revolutionary developments may be expected before another generation grows to adulthood.

Animal breeders are keeping pace with the plant breeders. Out in South Dakota, James W. Wilson, the son of "Tama Jim" Wilson, who was Secretary of Agriculture under four presidents, has developed a new and superior breed of baldfaced sheep without tails. The troubles that accompany tail-docking are thus eliminated in this breed, but more important than that, the wool of the tailless sheep possesses uniformly superior properties and the animals are larger and their meat is better. This baldfaced sheep can withstand the severe snows and sleets of far northern winters, with consequent reduction in losses from these causes. Here again is work that opens a vast new field of possibilities.

Animal fats are being investigated. There are dozens of such fats, the types of which physiologists are seeking to identify. For example, a steak of beef may have two fats, one energy-producing and the other useless material so far as its energy value is concerned. These two types of fat occur also in sheep and hogs. Glandular manipulation might make it possible to produce at will the type of fat wanted, and in turn wide uses may be found for specific kinds of fats in medicine, in biology as media for the culture of organisms, and in large-scale industry.

NEW FARM POWER SOURCES IN PROCESS OF DEVELOPMENT

Undoubtedly new sources of cheap power for farms will be developed. By putting cellulose waste such as cornstalks and straw through the same process that is used in treating sewage in a septic tank, the Illinois Experiment Station obtained enough gas to operate an engine. Employing old newspapers, peanut hulls and similar organic wastes in the same process, Virginia Polytechnic Institute secured gas sufficient for all its laboratory and institutional requirements apart from straight heating and lighting. The gas so generated is similar to common consumer gas.

Power derived from solar energy is yet another possibility that a scientist no less than Prof. Colin G. Fink, of Columbia University, believes is nearer realization than we think. A New Jersey inventor has just patented a refrigerator that utilizes the sun's heat for refrigeration through the evaporation of ammonia. The California and Alabama experiment stations have been able to secure water temperatures of 300 degrees (Fahrenheit) under a well-insulated solar heater. This offers a practical means of supplying hot water for dairy and household purposes.

Most of these projects are still in their infancy. However, they indicate the trend of scientific thought on behalf of the farm and isolated home. Moreover, the instances I have cited are merely typical and in no sense conclusive of the general effort that is being made to build an agriculture based on science. The point I wish to emphasize is that this effort *is* being made, that enough has been accomplished to convince anyone with an iota of vision that we are entering a new phase of agricultural activity that will spell opportunity to those who are prepared for it. But those unprepared will be worse off, if anything, than at present.

FARMERS MUST KEEP PACE WITH NEW DEVELOPMENTS IN CROPS, METHODS, AND EQUIPMENT

Farmers will have to know infinitely more to produce successfully the crops and to utilize the methods now taking form in the laboratory. They will have to develop a practical knowledge of soil chemistry, of plant pathology, of agricultural engineering, and have at least a basic knowledge of biology. Culture is all important in plant production; environment and feeding are all important in animal breeding and care. Lack of knowledge of a single subject such as moisture content of soil may upset an otherwise sound program.

That brings us to still another serious weakness in our existing agriculture, the lack of knowledge of modern methods that pervades not a few but millions who are seeking a livelihood from the soil. The situation is bad as it is now, but it will be progressively worse if effective education is not a part, and a major part, of any program for the improvement of agriculture through scientific research. Too often in the past we have locked the door after the horse has been stolen—soil erosion is a flagrant example. Let us not repeat past mistakes.

Through enormous effort but relatively modest expenditure we have established a national system for agricultural research and education. It has been responsible for most of the progress in agriculture in the past. Without our state colleges, without our county agents, without the work of earnest men in the federal services who have devoted their lives in the betterment of farming in America, there would be no mere "farm problem" today—there would be a farm debacle. These services that have proven their worth should be extended, and through them definite steps should be taken to carry knowledge to those millions of farmers who so vitally need it.

Before such an effort can be made on the scale demanded, however, we need more agricultural scientists, more teachers, more agricultural engineers. Especially do we need more engineers, and we need them urgently. What the chemist develops, what the breeder creates, indeed whatever new there is that will come into this scientific era of agriculture, will require the engineer to translate it into practical on-the-ground action. There are only 800-odd of us now. We need 8,000. The shortage in agricultural engineering ranks at this moment is dramatically indicated by the fact that a Texas college, which last year graduated seventeen men, could have placed ninety-three men in jobs.

We need fewer politicians who are interested only in farmer votes, and fewer tragedians who weep crocodile tears at every mention of the farmer. Give us, not alone science in agriculture, but also scientific thinking and action in making the fruits of science generally applicable, and the farmers of America will more than take care of their own in competition with the world.

Farm Electric Milk Cooler with Pneumatic Agitation

By John E. Nicholas

THE FARM milk cooling problem has become of national interest and importance. The producer and the distributor are mutually cooperating to safeguard the quality of the milk from the time of production until it is consumed.

Many investigators, who have studied the farm milk cooling problem, have realized that there are no universal standard temperature requirements to which milk should be cooled, yet health and municipal authorities fully agree that milk should be promptly cooled to below 50 degrees (Fahrenheit).

Experimental evidence by Prescott[1] showed that milk cooled and kept at 45 degrees will have the original bacterial content remain constant. To provide some margin of safety during the interval when the milk leaves the farm cooler until it is again iced for long distance transportation, I have suggested[2] that 40 degrees be the recommended temperature. An argument is frequently advanced that since there is germicidal action taking place during an interval of two hours after the milk is drawn, there is no need to cool it. Fayer[3], however, has definitely established that "germicidal effect cannot be depended upon as an adequate substitute for promptness in subjecting milk to a proper cooling medium." A second school of thought advances the erroneous theory that milk, when drawn, is slightly alkaline; therefore, bacteria will not multiply, and consequently cooling is not immediately essential. According to the associates of Rogus[4], who have reviewed the available information on the subject, freshly drawn milk is always slightly acid in reaction (pH 6.4 to 6.8). An alkaline reaction in milk is commonly accepted as an indication of severe mastitis and is practically never found in mixed milk.

Today there is no question but that immediate cooling definitely contributes to prolonging the original quality of the milk for a longer period of time and that milk should also be uniformly cooled to the desirable temperature of 40 degrees and with the least amount of unnecessary handling to avoid all possible contamination from outside sources.

Modern electric motor-driven milk coolers have been designed to meet these requirements.

Fig. 1 shows a cross-section side view of one of the most recent units, complete with all the auxiliaries necessary for its automatic operation. This report gives the results of tests made with this unit in the research laboratories of the department of agricultural engineering at Pennsylvania State College.

The compressor power unit is mounted on the right-hand side of the milk cooler cover. A unique feature is the pneumatic agitator used for circulating the milk cooling water during the first two hours of cooling. The pneumatic water agitator is a rotary air compressor operated from the end of the motor armature shaft of the refrigerating power unit.

The pneumatic agitator is put into operation by pouring a cup of clean water in the top filler hole. The water seals the rotor which pumps the air to the agitating air pipe located around the bottom of the cabinet and below the evaporating coils. These always carry a 3-inch bank of ice. The agitator air pipe is one-half-inch copper tubing with 1/16-inch holes drilled six inches apart through which the air is forced to provide agitation.

When cans are placed in the cabinet, the rising air

Journal Series Paper No. 732, Pennsylvania Agricultural Experiment Station. Authorized for first publication, June 2, 1936, in AGRICULTURAL ENGINEERING.

Author: Associate professor of agricultural engineering, Pennsylvania State College. Mem. ASAE.

[1]Prescott, S. C., "Bacteria as Affected by Temperature," Refrigerating Engineering, February 1932.

[2]Nicholas, John E., "How Cold Should Milk Be?" The Milk Dealer, June 1933.

[3]Fayer, J. M., "The Production of High Quality Milk." Bulletin 343, University of Vermont and State Agricultural College.

[4]Associates of Rogus. "Fundamentals of Dairy Science," 1935, p. 137. Chemical Catalog Co.

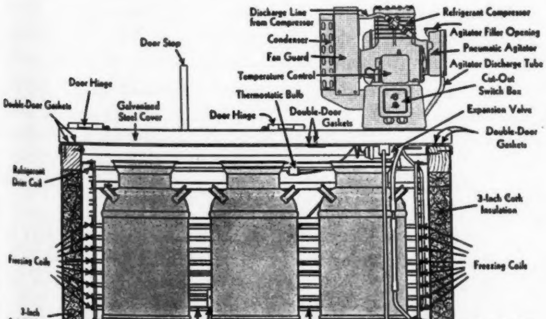


FIG. 1 A CROSS-SECTION VIEW OF AN ELECTRIC MOTOR-DRIVEN MILK COOLER WITH PNEUMATIC AGITATION. COOLING CAPACITY, SIX 10-GALLON CANS EACH TWELVE HOURS

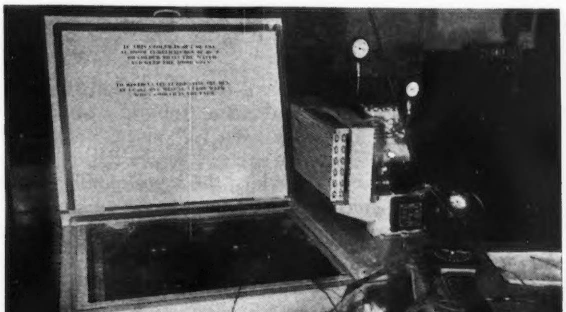


FIG. 2 EXPERIMENTAL SET-UP SHOWING RAPID TEST METER, SUCTION AND DISCHARGE GAUGES, AND THE TWO SETS OF THERMOCOUPLES USED TO MEASURE MILK AND WATER TEMPERATURES

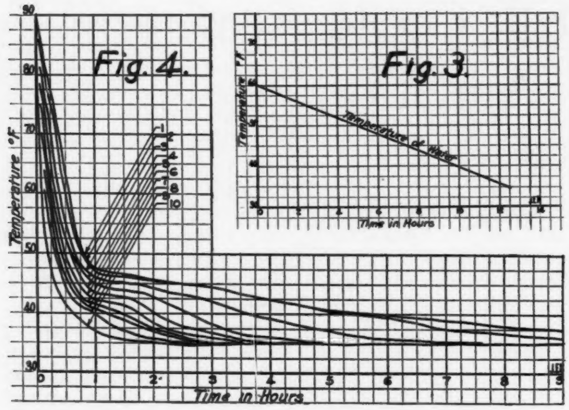
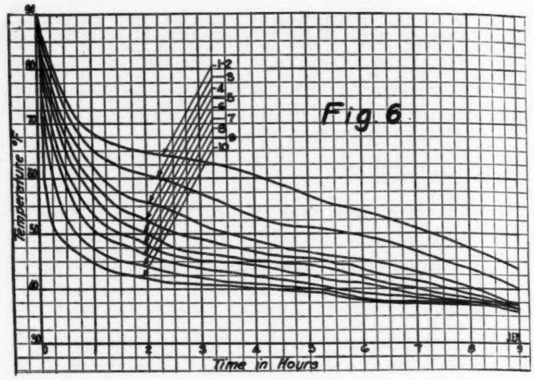
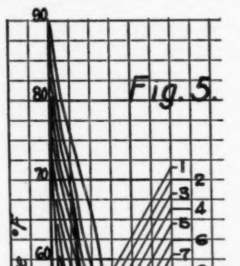


FIG. 3 (INSET) RATE OF COOLING 160 GALLONS OF WATER WITH AGITATION. FIG. 4 RATE OF COOLING MILK IN A 10-GALLON CAN MEASURED EVERY 2 INCHES FROM THE TOP DOWN THROUGH THE GEOMETRIC CENTER OF THE CAN (R = 1.65). AGITATION OF THE WATER CONTINUED FOR 2¼ HOURS





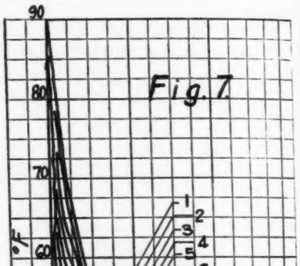


FIG. 5 (LEFT) RATE OF COOLING OF WATER IN A 10-GALLON CAN (R = 1.65). WATER IN THE CABINET WAS AGITATED. FIG. 6 (ABOVE) RATE OF COOLING MILK IN A 10-GALLON CAN UNDER CONDITIONS SIMILAR TO THOSE OF FIG. 4, BUT WITHOUT AGITATION. FIG. 7 (RIGHT) RATE OF COOLING OF A 5-GALLON CAN OF MILK (R = 1.8) WITH AGITATION OF THE COOLING MEDIUM

causes the water to pass the surface of the ice layer where it is cooled and circulated around the cans from the bottom to the top of the milk level. The ice bank is of sufficient refrigerating capacity to cool six 10-gallon cans from 90 to 35 degrees twice in succession and maintain the cooling water at 33 degrees. Six 10-gallon cans fill the cabinet to capacity at one cooling.

Table 1 shows the specifications of the unit used in these tests.

The compressor has two cylinders. There are 120 feet of half-inch copper tubing in the evaporating coil. The cabinet has approximately 81.6 square feet of outside surface.

Experimental Procedure. Fig. 2 shows the experimental set up.

The first test consisted in cooling 160 gallons of 60-degree water with the agitator in action. This test determined the rate of cooling this quantity of water and the time the agitator would operate on a cup of water. Fig. 3 shows the rate of cooling 160 gallons of water from 60.1 to 35 degrees. A cup full of water maintained the agitator in operation for two hours and twenty minutes.

After the water cooled to 35 degrees the agitation was discontinued. Forty gallons of water were then removed and the unit permitted to store up ice under the automatic control of the thermostat.

The energy required to cool the 160 gallons of water with agitation from 60.1 degrees and to build a bank of ice with the remaining 120 gallons was 9.25 and 6.50 kilowatt-hours, respectively.

This preliminary run provided the regular milk cooling conditions under which the unit operates.

Milk Cooling Test. The capacity of a milk cooling unit has generally been expressed in terms of the number of 10-gallon cans it would handle in 24 hours. The rated capacity of this unit is six 10-gallon cans at once or 12 cans in 24 hours. To provide proper water level for six cans at a time, it was necessary to remove an additional 21 gallons of the water from the cabinet, leaving 99 gallons, which gave a water to milk ratio "R" 1.65, for the test, with approximately 260 pounds of ice banked on the coil as available refrigeration.

Fig. 4 shows the rate of cooling of the milk as measured by 10 thermo-couples spaced 2 inches apart. The actual load on the machine was one 10-gallon can of 90 degree milk and five 10-gallon cans of 90 degree water. There are approximately from 170 to 200 more Btu in 10-gallons of water than there are in an equal quantity of whole milk.

Fig. 4 shows that all of the milk initially at 90 degrees was below 50 degrees in ¾ hour. Curve 6 represents the approximate average temperature of all the milk. In other words, the average temperature of the milk is 40 degrees at the end of 1¾ hours. The top of the milk can actually reaches 40 degrees in 5½ hours.

Fig. 5 shows the rate of cooling of 90-degree water in a 10-gallon can under the same conditions as for the milk, shown in Fig. 4. (R = 1.65). The entire contents of the can was at 35 degrees in 1½ hours. Fig. 5 is of particular interest in comparison with Fig. 4 because most experimental results have been based on water.

It has been recognized that the agitation of the cooling media is necessary if rapidity and uniformity in cooling of the milk is desirable.

Fig. 6 shows that a large temperature gradient exists in a 10-gallon can of milk during the cooling process when the cooling media is not agitated.

TABLE 1. SPECIFICATIONS FOR ELECTRIC MOTOR-DRIVEN MILK COOLER WITH PNEUMATIC AGITATOR

Capacity	Electric motor, 60-cycle a-c, single-phase					Refrigerating compressor				Motor pulley	Cooler cabinet outside dimensions		
Regular 10-gal cans	Horse-power	Full-load rating: Amp	Full-load rating: Volts	Min. gauge line wires, B & S	Motor line fuses, amp. rating	Comp. speed, rpm	Bore, in	Stroke, in	Pulley outside dia, in	Outside dia, in	Length, in	Width, in	Height, in
6	½	10	110	14	15	350	1⅞	2¼	16	3½	59⅜	41⅛	34⅜
		5	220	14	8								

This unit provided the necessary facilities to obtain experimental evidence on the comparative rates of cooling milk in 5 and 10-gallon cans with agitation. The comparative results are shown in Figs. 4 and 7.

Fig. 7 shows the rate of cooling and the temperature gradient in a 5-gallon can of milk with agitation of the cooling media. There were but 8 thermocouples used. Curve 5 represents the average temperature of the milk which shows that the entire contents reached 40 degrees in 1¾ hours. All of the milk is below 50 degrees in ¾ hour and below 45 degrees in 1½ hours.

Fig. 7 does not indicate that the rate of cooling of milk in a 5-gallon can is much more rapid than a 10-gallon can. There is, however, a slight advantage.

DISCUSSION OF RESULTS

The refrigerating capacity of the unit is 2700 Btu per hour as determined by the rate of cooling 160 gallons of water in a 77-degree room temperature (Fig. 1).

To cool 160 gallons of water from 60.1 to 35 degrees required 12½ hours and an expenditure of energy of 9.24 kilowatt-hours with agitator in operation. Without agitation the cooling would have required but 8.00 kilowatt-hours.

Energy supplied to the motor, at 3-pound suction and 69-pound discharge pressures in 77-degree room temperature, as measured by a portable rapid meter was 740 and 640 watts with and without agitation, respectively.

A cup full of water will maintain the agitator in operation for 2¼ hours, which is sufficient time to bring all of the milk to below 45 degrees (cooling from 90 degrees).

Milk cools to 50 degrees in ¾ hour (inital temperature of the milk 90 degrees). The average temperature of the milk at the end of the first hour was 42 degrees (Curve 6, Fig. 4).

The total time the machine operated was 20 hours and 18 minutes, to cool 115 gallons from 90 to 34 degrees. This included the morning and evening milk. Total energy used was 12.45 kilowatt-hours.

The cooling water never exceeds 34 degrees when six cans of 90-degree milk are placed to cool at one time and only half of the available ice was used up at each cooling.

In reporting the results on a study made at 44 dairy farms, Hotis and McCalmont[5] state that "if the efficiency of operation is to be assured, the compressor should not run over 14 hours per day and a machine running on an average of 9.1 hours per day used 4.3 watt-hours per gallon degree." This unit operated 20 hours and 18 minutes per day and gave a performance of 1.933 watt-hours per gallon-degree.

The ice bank provides sufficient refrigeration capacity to hold the cooling media at 33 degrees during the cooling process.

Milk cools faster and more uniformly with agitation. Compare Figs. 4 and 6.

Fig. 5 shows the rate of cooling of 10-gallons of 90-degree water. At the end of 1½ hours the entire contents is down to 35 degrees. Most experimental studies with electric motor refrigerating units have been based on temperature gradient in which water was substituted for milk. Figs. 4 and 5 are therefore important.

A water to milk ratio of $R = 1.65$ is sufficient when an ice bank is available to hold and maintain the cooling media at 33 degrees.

This system of cooling, in my opinion, is more desirable than the aeration method as applied on farms. The aerator is an added source of possible contamination, first, by exposing the milk during the cooling, and, second, as an extra utensil which requires scrupulous cleansing and sterilizing.

[5]Hotis and McCalmont, "Cooling Milk on the Farm with Small Mechanical Outfits." USDA Circular No. 336.

Ditch Blasting in Marshy Areas

WHERE the material to be removed in a clean-out operation is more or less solid, it can be blown out by loading the dynamite in holes in the center of the ditch; this, irrespective of the type of soil. But where the mud is loose, soft or semi-liquid, the ordinary method of loading can not be depended upon unless the bottom and the sides of the ditch are very firm.

In low marsh land, especially in coastal localities where the soil is unstable to a great depth, it follows that the bottom and the sides of a ditch are anything but solid. For that reason, loading in the center should be avoided if the mud to be cleaned out is soft. The result of the blast is that the soft material is not thrown clear of the ditch, while frequently the sides are broken loose.

Various methods of loading for cleaning out ditches in very soft marshy areas have been tried by agricultural engineers and practical blasters, but in the past none had proved very satisfactory. However, recent experimental work indicates that when the dynamite is loaded in a line close to one side of the ditch, the blast will scoop out the soft material and throw it in the direction of the opposite side. At the same time, the ditch is usually widened by the breaking away of the bank back of the line of holes.

While the work done up to this time by the method outlined has been very satisfactory, it is to be understood that a standardized practice has not yet been developed. At present the proper location of the line of holes in relation to the edge of the ditch can only be determined by trial shots. Similarly, there are no definite data on the quantity of dynamite to use or other details.

The results obtained by the limited experimentation which has been carried on offers promise of the eventual development of means whereby any experienced blaster may do clean-out work in marshy soil successfully.

Pyrethrum Harvesting

PYRETHRUM, an insecticide crop, is under cultivation to a small extent in Pennsylvania, but requires a special harvester before farmers can be generally interested in its production.

It is a perennial belonging to the chrysanthemum family. Its bloom, which resembles the common field daisy, is toxic to most insects and is used in certain spray materials and insect powders. Because the toxic material is not harmful to human life, spray materials containing it may in some degree supplant poisonous chemicals now used on fruits and vegetables. Manufacturers of spray materials and insect powders in this country who use pyrethrum import the dried flowers from Japan and south-eastern Europe, where they are harvested by hand or with devices that require much hand labor. Work done by W. M. Hurst, of the USDA Bureau of Agricultural Engineering, in cooperation with the Bureau of Plant Industry, indicates that a satisfactory machine may be developed for successfully and economically harvesting this crop.

Observations and tests made by the Bureau of Plant Industry indicate that pyrethrum plants may be harvested with a binder, dried in shocks, and then threshed to separate the flower parts from the stalks.

Several farmers in Pennsylvania have used sickles for cutting the plants, and a cylinder somewhat similar to those on grain threshers for stripping the flowers from the stems before drying. When such equipment is used, the plants are cut, carefully loaded on a wagon in small, untied bundles, and hauled to the barn where they are unloaded by hand and the top end of each bundle held against the cylinder. The stripped flowers are then spread to dry in thin layers under shelter.

With such methods, the pyrethrum flowers contain very few stems or other foreign material, but a great deal of hand labor is involved. The crop is usually ready for harvest in June, when other farm work is urgent. For these reasons it is essential that some satisfactory equipment be developed for harvesting the crop, if it is to be grown commercially in this country.

A modified cotton stripper was tried out on pyrethrum early in June, 1935, at the Arlington Farm in Virginia. The results indicated that the teeth on the stripping rollers were spaced too far apart. The teeth were removed and angle iron strips fastened to the rollers by cap screws. These angle irons proved much more satisfactory than the teeth, and the machine was later taken to Bell, Maryland, for additional trials. There the pyrethrum plants were standing mostly upright and the efficiency of the stripper under such conditions justifies the belief that it can be further modified to handle the crop satisfactorily.

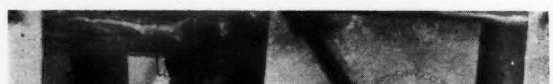
Some of the crop at Bell was harvested with a grain binder, and shocked in the field to dry. Some difficulty was experienced in getting bundles with the pyrethrum flowers extending uniformly from the end.

Both the stripper and the binder were taken subsequently to Belleville, Pennsylvania. There, also, there were no lodged plants and the stripper worked satisfactorily, removing about 95 per cent of the flowers with very little stem and leaf material. The binder then was operated as a mower, after removing the platform canvas and the sheet metal table on the platform. The purpose was to see if a mower equipped with a reel would lay the plants back on the stubble in such a manner as to be easily picked up by hand in bunches for stripping with the machine used in Pennsylvania when the plants are cut with hand sickles. Some of the plants were dragged along by the cutter bar, but in general the stems and flowers were left in such a manner as to be easily picked up by hand in small bundles.

Near Lancaster the stripper was tried out on a crop that was badly lodged and much heavier than those previously harvested, and a higher percentage of leaves and stems was gathered along with the flowers. The results obtained indicated the need for a pick-up device to gather down stalks, and other changes that will adapt it to a wide range of conditions.

The accompanying picture shows the stripping rollers in the machine.

Persons familiar with the production and use of pyrethrum, who saw the machine in operation, were of the opinion that the stripper has greater possibilities for harvesting this crop than any other machine which has been tried. Therefore, plans have been made for certain alterations on the cotton stripper, and for construction of an experimental stripper designed especially for pyrethrum. It is planned to try out these machines, after the changes are made, under as many conditions as possible, in the season of 1936.



A COTTON STRIPPER WITH FLANGE ROLLERS HARVESTING PYRETHRUM FLOWERS. THE PICKED FLOWERS IN THE TROUGH ALONGSIDE THE ROLLERS ARE RAKED TO THE REAR OF THE MACHINE

A contribution from the division of mechanical equipment, Bureau of Agricultural Engineering, U. S. Department of Agriculture.

Looking Ahead in Agricultural Engineering

By H. B. Walker

MY SUBJECT relates primarily to the future. For that reason it should be of greatest interest to the younger men in our profession. What I have to say is essentially nontechnical and deals mostly with our professional future rather than with the forces and materials with which we work. Some of my statements may seem a bit contradictory, but out of it all I hope to contribute to a professional consciousness needed for our future growth.

The forward look is as essential to advance in professional life as it is in driving a car on the highway. The speed and safety of our progress in either case depends upon our visibility. I feel complimented in being selected to speak on this subject even though I am conscious of the limits of my vision. In any case I hope I may avoid the pitfall of prophesy or forecasting.

Recently, in looking over a 1909 copy of the Year Book, U. S. Department of Agriculture[1], I came upon this statement: "Because of the scarcity of wheat and accompanying high prices in recent years, there has been considerable discussion of the question of future wheat production in this country. Doubts have been expressed by some that we shall be able much longer to furnish our own people with sufficient wheat for bread."

It is unnecessary for me to refer further to the doubts raised at that time, since our greatest worry in recent years has been to find an outlet for the wheat we are growing under restricted production programs. It is interesting, however, to point out that those who were optimistic regarding our future wheat supply, based their opinions not only upon increased acreages, but on an average yield of 20 bushels per acre, which of course is far beyond our actual attainments. Furthermore, demand was based upon a population of 160,000,000 by 1950 and a per capita consumption of 7 bushels. These data, which appear to be in error in many particulars, are significant at the present moment to point out the unreliability of long-distance forecasting, even under the conservative influence of a large national organization.

In looking ahead then, we are first of all concerned with our visibility. From the standpoint of the weatherman, the distance we can see on any given occasion is called the visibility[2].

The atmosphere as we know is composed largely of nitrogen and oxygen with smaller but readily measurable amounts of carbon dioxide, argon, and other gases. These gases, in themselves, are remarkably transparent. In fact, meteorologists say it may be calculated, that in an atmosphere containing nothing else an aviator could make out a mountain 250 miles away. It is well known, however, that under actual atmospheric conditions such visibilities seldom occur, which suggests that the air must be full of a number of things other than the gases mentioned. Naturally we think of water vapor which is always present, but this also is very transparent to the kind of radiant energy which our eyes recognize as light so long as this moisture does not form into droplets.

The air has in it, however, little nuclei which are larger than the air-molecules and which may consist of groups of gas molecules, tiny particles of salt, or products of combustion. Now these molecules collect water, and when we have a lot of nuclei with water on them the atmosphere is hazy, and hence visibility is affected.

No doubt in 1909 the visibility for wheat production and consumption was a little hazy, because of certain unrecognizable nuclei such as foreign exchange, per capita consumption, tariffs, population growths, and myriads of other influences relatively insignificant at the time but enough to make visibility hazy and which later precipitated important changes.

I speak of these not as an alibi for myself, however desirable and comforting that might be, but to fortify those who do me the honor of listening against too much confidence in my interpretations for the future of our profession whether favorable or unfavorable.

Visibility today is still hazy. Not only do nuclei obstruct distant vision but also the clearness. It has been said "that our hind sight is better than our foresight." The speakers preceding me have presented a very clear vision of our past achievements, and if we have faith in the method of projecting into the future our curve of achievement there is much evidence for encouragement.

HAZE IN THE SOCIAL ATMOSPHERE

I suppose it is human nature to feel that the nuclei of uncertainties contributing to the haze before us are more numerous for our time than any other. Whether this is true or not, and I doubt if it is, it is well to remember that in this same haze the nuclei for development and improvement are there with the uncertainties, awaiting the approach of the courageous. It is true there is social, economic, and political unrest, which influences the conduct, habits, and methods of thinking of folks, and these in turn are factors in human progress.

The population trends in 1909 no doubt indicated that our nation would have 160 millions of people by 1950. There were some who predicted it would reach 200 millions. Today no one could be so optimistic. In fact, we are rapidly approaching a population plateau of tremendous importance to us nationally if our present attitude toward family life continues. Our economic thought changes as well. This is aptly illustrated by an occurrence purporting to have come from a modern school room. A teacher asked a small boy in her arithmetic class if his father saved a dollar per week for four weeks, what would he have? Promptly the youth responded, "A radio, a refrigerator, a toaster for mama, and a new set of golf clubs."

These are factors beyond the comprehension of man when making long-time studies of the future. They are difficult if not impossible of scientific analysis although they are subjects of extensive study and experimentation. Unfortunately, we do not have as yet scientific data upon which to predicate such influences. The history of science indicates that the value of research varies directly with the

---

An address before the annual meeting of the American Society of Agricultural Engineers at Estes Park, Colorado, June 24, 1936.

Author: Professor of agricultural engineering, University of California. Mem. ASAE.

[1]Carleton, M. A. The Future Wheat Supply of the United States, Year Book of the Department of Agriculture, 1909, pp. 259-272.

[2]Middleton, Knowles, W. E. How Far Can We See? Scientific Monthly, October 1935, pp. 343-6.

accuracy of measurements. Lord Kelvin[3], the distinguished British physicist, is reported to have once said: "When you can measure what you are speaking about, and can express it in numbers, you know something about it, and when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind. It may be the beginning of knowledge but you have scarcely in your thought advanced to the stage of science." These factors of human conduct are more or less non-quantitative, and hence experimentation and research yield little of permanent scientific value. Furthermore, our ideas are always influenced by our environment. Human estimations are made by humans, and it is human instinct to size up a situation from the private viewpoint. There is an old saying, "We believe what we see, when we see what we want to believe." These, therefore, are limitations in human judgment and analysis.

THE SEQUENCE OF TECHNOLOGICAL INFLUENCES ON SOCIETY

We live in what most everyone chooses to call a scientific environment in which the technological sciences are important. These have had a great influence upon the transformation of our environment and accordingly these influence our thoughts and subsequent action. Usher[4], in his book on the history of mechanical inventions, says in substance that there is a definite sequence to these technological influences. First, we have the technological change in which the scientist and inventor are largely responsible. This is followed by a second situation, namely, the development of the consequences in which the efforts of the scientist and inventor are subject to exploration and exploitation. Finally, a third condition prevails in which we have revision of laws and customs to meet the new environment. This last situation, according to Usher, is the task of the statesman.

Judging from the activities of the present, we must be in this third phase of technological change. At any rate the activities of our statesmen have injected much in the way of laws and regulations to cloud our forward visibility.

We may look upon many of these laws and regulations as an attempt toward regimentation of a sort and an infringement upon personal freedom, but, if we are conscious of the new forces, and modern facilities which are every day factors in our lives as a result of expanding applications of science we must admit that we unconsciously subject ourselves to various forms of regimentation.

It may be said that science is truth and "the truth shall make us free," but this does not in any sense guarantee individual freedom. In fact science tends to regiment human actions. As we come to know more about the fundamental relationships between things, the primary quantities of force, time, and distance become more and more respected and useful. This applies to both physical and biological phenomena, and with this knowledge, it is not only desirable but necessary to set up regulating devices, and to follow timely practices in order to achieve and to protect ourselves.

Hence, we have traffic signals on our streets and highways to regiment drivers of vehicles, and we have specific kinds of materials and definite times to apply an insecticide to control insect pests. Thus we regiment ourselves to a practice in order to prolong human existence and to insure human supremacy.

However, in spite of this the adjustment of technological development to life sometimes involves radical changes in laws and customs, and recently these have come upon us at such a rate that it is difficult to chart human progress with any degree of certainty.

There are a few things, however, very close to the future of engineering in agriculture where individual freedom has not as yet been seriously questioned, and these, so it seems to me, are harbingers of a continued and growing need of the engineer in the industry. For instance:

1 No serious restrictions as yet have been placed upon independent thinking, or universal public education.

2 No organized resistance to human efficiency has been attempted even though some administrative regulations apparently have ignored it.

3 No one has advocated waste in land or other basic resources, even though this has taken place under short-time economic planning.

4 No one has advocated poorer housing and fewer comforts for our people.

5 No one is openly advocating peasantry as a desirable mode of life for our rural folks.

All of these are significant to the future of engineering in agriculture.

It is difficult to make an adequate appraisal of the importance of our public school system upon national progress, for it develops both a progressive and a highly critical citizenship. Education appeals to that human instinct to seek relative advantage and security for it is recognized as a valuable tool in shaping one's future destiny. The primary purpose of education is to train folks to think and most thought is followed by action which, if intelligently done, results in human progress. At the same time, thoughtful people are apt to be the most critical for they are doubters. There is a saying that "when people do not think they believe, and when they begin to think, they begin to doubt." There is much of truth in this, but on the whole it is not alarming for thinking folks are less likely to be swayed by radicalism than uneducated groups. Surely our public school system is a bulwark to our national progress and security.

THE TAP-ROOT OF TECHNOLOGICAL PROGRESS

Man in his quest for advantage and relative security naturally seeks less arduous ways of doing things. This instinct has brought about the numerous inventions of which we are beneficiaries today. An invention comes from a need, a desire, and it represents a completed idea. It is a product of thought. So long as humans have work to do, and at the same time have some opportunity to organize their mental resources through some form of universal public education, we will have technological development. Statesmen may delay the development of ideas through laws, regulations, and taxes, but so long as men think, ideas will develop and new and better methods will follow.

Engineering by nature and necessity is an applied science. It is a field in which fundamental principles developed largely through the work of pure scientists are moulded into methods, machines, structures, and practices contributing to technological development and the subsequent inevitable changes in the environment of men. As I see it, engineering is an essential link in transforming principles into practice and this is of tremendous interest to the public at large, for the masses of the people are more interested and concerned with the applications of science than they are with its purity. Furthermore, the engineer is trained to be ever alert to the needs of others. He becomes, therefore, a form of integrator between the pure

[3]King, Ronald. Physics, Metaphysics and Common Sense. The Scientific Monthly, April 1936, pp. 301-311.

[4]Usher, A. P. A History of Mechanical Inventions. McGraw-Hill Publishing Co., New York. 1929.

"OUR FUTURE AS ENGINEERS IN THE SERVICE OF AGRICULTURE DEPENDS ON OUR STRICT ADHERENCE TO TANGIBLE VALUES"

sciences on the one hand and the wishful desires of a people on the other.

There are numerous scientific applications in agriculture coming primarily as direct contributions from the biological sciences which attain economic fruition through engineering works and methods. The application of an insecticide, for example, may, and in fact usually does, depend upon the proper development and use of correctly designed machinery. The economic marketing of fruits and vegetables involves refrigeration of conveyances and warehouses, washing and bleaching of products, and dozens of other desired and necessary operations involving engineering technique.

Likewise, these technical services to the agricultural industry involve the ability of engineers to work with biological scientists, and vice versa. Neither one can attain his greatest potential service to agriculture without the other. This adds, of course to the complexity of the service, but likewise to the interest of the work. This sort of team work has produced already significant results, and it offers tremendous potentialities for future scientific progress in the industry. It must be admitted that such technical teamwork accelerates change both social and economic, but this is inevitable. Of one thing I am very certain; the agricultural engineer of tomorrow must be technically versatile and able to cope with change. For him to become static either in thought or action is fatal to professional development.

It would be avoiding a present day issue to say that agricultural engineers are not concerned with labor-saving devices, and it would be very inconsistent for them to claim responsibility for labor-saving equipment and then try to convince the public that labor-saving machines create labor. Fundamentally a labor-saving machine would not be worthy of the name if it did not actually save labor. No doubt some of you are ready to take issue with me on this statement, but I hope this will be unnecessary.

Interpretation in this case may depend upon point of view, or the nature of the values to be considered, whether tangible or intangible, and upon benefits, whether direct or indirect.

As engineers we are accustomed to dealing with tangible values and we are conscious of the elusiveness of intangible ones. When we design a labor-saving machine it must actually save labor—that is tangible—and if we should say, that labor-saving machinery creates labor, as, for example, by making possible the development of latent resources—that is intangible. In the case of actual labor saving, the user of the machine receives a direct benefit. However, in the latter case of the development of latent resources, any benefits accruing, even if evident as a whole to society, are not readily assignable to a particular person or group so these become indirect.

Speaking as an engineer to engineers, I am convinced, and I feel you must agree with me, that our future as engineers in the service of agriculture, depends upon our strict adherence to tangible values in solving our problems and the measure of our services must depend upon the direct benefits accruing.

This need not imply that we as individual citizens should be indifferent to such problems as the social and human benefits accruing from our endeavors, but if we achieve in the development of the material things with which engineers must work we cannot deviate very far from the use of tangible values to obtain direct results.

I do not mean by this that as engineers dealing with the materials and forces of nature for the benefit of mankind, such as machinery design and production, that we should be, in ourselves, indifferent and heartless, but we must recognize that machines, in themselves, are inanimate things to be directed by man for good or evil depending upon man's capacity to utilize. It is a commonplace to assert that machines should be for the ultimate benefit of society as a whole. That is self-evident. In engineering design and application, however, engineers must be strictly technical and analytical by using and applying known principles and tangible values for direct benefits and results.

Material progress has greatly lessened the physical tasks of human beings. Surely this is true for most production and particularly for farm products. There are those in our nation, however, who look upon machines as an evil influence, in that they deprive mankind of its right to earn a livelihood. This they do in spite of the fact that the machine age has contributed manifold conveniences to our modern existence. And this too is a natural consequence. The group so affected sees only the machine and these unfortunates are conscious of their own relatively miserable circumstances. There may be no condemnation among them of the work of the machine as work, neither do they condemn the quality of its performance, but they as individuals enjoy relatively less of the fruits of machine use so they as individuals consider machines as competitors. This condition, unfortunate and regrettable as it may be, is a part of the sequence of technological change. It calls for adjustments in laws and customs—not to do away with labor-saving devices, but to make such changes as may bring to each deserving citizen the rewards which rightfully should be his.

SOCIAL JUSTICE CANNOT BE BUILT INTO A MACHINE

My point is that machines in themselves being inanimate are developed through holding tight to tangible values, and this being true it is as yet, and probably always will be, impossible to design into them social justice or other intangible values. As engineers in the practice of our profession we must recognize, first of all, our direct professional responsibilities and be prepared to meet these with the same technical precision as is found in the laws and principles upon which our subject matter is founded.

Statesmen may pass laws calling for physical developments, the benefits from which are to be measured in some degree by social values. Included in these programs may be engineering works of importance. As I see it, the engineer need not hesitate to take his place in the engineering phases of such projects so long as he is not restricted or restrained in the honest practice of his profession, even

though he personally may be in doubt as to the ultimate social objectives. The latter are the responsibility of society as a whole and somewhere in society there should be those who are as well or better equipped than the engineer to analyze and place such intangible values. The engineer, however, must accept full responsibility for the technical integrity of his part of the project. That is, his machines should be capable of rendering a service; the dams and bridges he builds should stand up; his warehouses should meet specific requirements; but social and certain intangible types of economic outcomes should not be placed at his doorstep. As I see it, for the engineer to assume such a responsibility is to invite loss of technical prestige. We have in this country today thousands of structures and other engineering achievements as evidence of engineering skill and which are important factors in social progress, but, as might be expected, there are relatively few social achievements or reforms as such for which the engineer may claim direct distinction.

ENGINEERING THINKING DICTATES CLOSE ADHERENCE TO TECHNICAL PHASES OF WORK

Engineering in the future as in the past calls for higher efficiencies. It is a reflection upon the intelligence of a people if it persists in doing things by difficult or primitive methods when it knows better ways. The agricultural engineer of tomorrow will be seeking constantly better methods and practices for agriculture because thinking people will demand it. He will not be creating work for work's sake, but he will create improved machines and methods for the sake of doing work more effectively. To neglect efficiency is an engineering crime; to legislate against it is to my way of thinking a mark of ignorance and the forerunner of national deterioration.

I cannot bring myself to think that inefficient methods will be attempted willfully by statesmen seeking ways for social justice even though for the time being it may sometimes appear to be ignored. Our own President in a recent talk at Baltimore, Maryland, referring to our unemployment situation, made the following significant, and perhaps to some a comforting statement: "It does not matter very greatly what the cause of this (unemployment) is. It may be greater efficiency; it may be the development of new machinery; it may be a variety of other causes. We cannot legislate against greater efficiency nor can we legislate against the use of new tools—nor would we if we could."

It is conceivable, of course, that efficiency may have different meanings with different methods of thinking. There may be, and no doubt should be, some differentiation between engineering efficiency and social efficiency although with the latter, social effectiveness seems to fit better. Engineering has been defined as a method of thinking. So far as engineering is concerned our definition for efficiency is tangible, definite, and based upon fundamental concepts. This method can hardly be applicable where social problems are involved. In social applications it should be broader and more flexible so that intangible situations can be met. Probably for such conditions it may be interpreted in a more elastic way, as an Alabama negro, named "Ben", interpreted his shoe requirements. This negro needed some footwear and in keeping with a good old southern custom he asked "his white folks" for some cast-off shoes. Ben's feet were of generous proportions, and he was told that the used family shoes were of doubtful value to him because of inadequate size. To this Ben very hopefully replied: "I wears from sixes up."

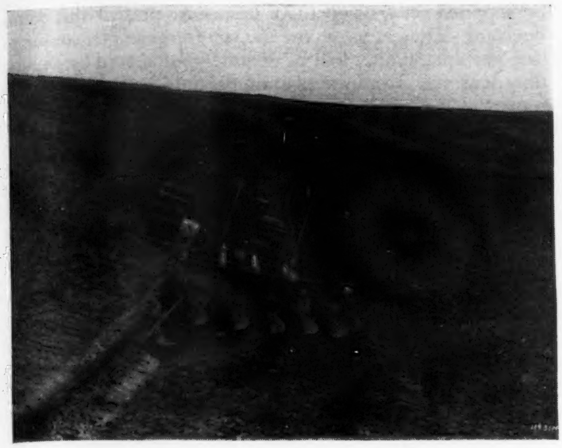
Such elasticity, however justifiable it may be for others in meeting particular situations, does not meet the requirements of the engineering method of thinking. For this reason I feel, that we as agricultural engineers, will give our greatest future public service by adhering rigidly to the technical phases of our chosen field, wherein we can maintain our own tangible standards.

The emphasis now placed on the conservation of our agricultural resources of land, water, and forests is of particular significance to the future of our profession. While it is true that certain types of exploitation has reflected on engineering works, particularly in various types of land development, the fact remains that in any type of effective land conservation work having agricultural objectives in mind, the services of the engineer must be included.

I like to look at this type of service as incidental to the principal objective, just as I look at all engineering in agriculture as incidental to the industry. In doing this I feel there is no danger in belittling ourselves so long as we live up, in full measure, to the engineering responsibilities involved. It matters but little whether the man in charge of a specific soil conservation project is an agronomist, geologist, botanist, soil technologist, an engineer or a lawyer, so long as sound conservation programs are being executed. But if such projects were carried on exclusively by agronomists or botanists or geologists or soil technologists or agricultural engineers or lawyers, some serious doubts might well be raised as to the wisdom of the programs; for it is obvious, in projects of this sort, that an integration of the various applied sciences is essential. Accordingly, in the future as it has been demonstrated so often in the past, the agricultural engineer who recognizes his most useful place in this integration process, in which he is only a factor, will contribute in fullest measure to the advancement of conservation. In doing this he will, likewise, bring greater distinction and satisfaction to himself as well as the profession he represents.

Conservation of agricultural resources while not basically engineering involves many important engineering problems. So long as crops are grown from the soil, water in suitable quality and optimum quantity will be essential for profitable production. As our agriculture is better understood both from the scientific and practical viewpoints, the necessity of proper water relationships becomes increasingly significant. The problems of storage, distribution, and measurement of water together with land preparation are agricultural engineering problems which continue from year to

WHETHER OR NOT ENGINEERING SERVICE OR ENGINEERING EQUIPMENT IS OF BENEFIT TO SOCIETY DEPENDS ON THE ATTITUDE AND VIEWPOINT OF THE DIRECT BENEFICIARIES



"IT IS HARDLY POSSIBLE TO DEVELOP LAND-USE FORMULAS BUT IT SHOULD BE POSSIBLE AND PROFITABLE TO PROMOTE PROGRAMS HAVING AN EVOLUTIONARY INFLUENCE ON SENSIBLE UTILIZATION"

year. Under restricted production programs new emphasis automatically is directed toward land preparation for production, by leveling, drainage, erosion control, clearing, fertilizing, tillage, cover crop handling, seasonal and timely operations, quality production, etc., all of which indicate that the agricultural engineer of tomorrow must be sensitive to the changing trends, in order that he may properly orient his technical thought to meet the new conditions.

While it is true that agriculture is often, if not always, a modified form of mining for which engineers have devised many of the tools and machines used for exploitation of resources, it is equally true that these same implements properly and intelligently applied are effective and required for sensible production and conservation programs.

So it is with our engineering contributions to agriculture, as it is with any inanimate engineering equipment designed and manufactured to perform a specific service; whether or not its service is really helpful to society depends not so much upon the originator of the equipment, as it does upon the attitude and viewpoint of the direct beneficiaries. Engineering in itself, whether fortunately or unfortunately, renders and is responsible for a service which on the whole is measured primarily in terms of direct economic returns, and its contributions are not primarily weapons of destruction or waste. In fact, these become such only when used by humans blinded by direct selfish interests to the broader responsibilities of altruistic citizenship.

Hence the engineer of tomorrow will continue to design machines and structures to meet the needs of a thoughtful citizenship. There is no doubt in my mind about the future demand for modern farm machines and various types of mechanical power units. The highly efficient and splendidly organized farm equipment industry which today characterizes our nation is not a product of exploitation or accident, but it reflects the needs and desires of an educated, aggressive, forward-looking rural population. We cannot be too certain of the specific type of future farm power plant either as to size or type of fuel used, but we can confidently expect our farmers to continue to use in growing volume some form of mechanical energy. The farmer likewise has a right to expect the continued development of equipment to meet his specific needs as conditions influencing his production environment may change with the years ahead.

Land use is closely associated with the conservation of our agricultural resources. It is hardly possible to develop definite land-use formulas either empirically or rationally, but it should be possible and profitable to promote directional programs having an evolutionary influence upon sensible utilization. These directional programs, however, must be based upon proper inventories of soil, water, climate, and existing uses. In obtaining these data the engineer can make definite contributions. In the execution of programs many items less tangible are involved, such as human resources, economic balances, etc., and which the engineer is not so well prepared to manipulate without the cooperation of workers in other fields.

AGRICULTURAL ENGINEERS MUST KEEP CONSCIOUS OF THEIR LIMITATIONS

In such problems, the agricultural engineer of the future must be conscious of his limitations, as well as his responsibilities if his efforts are to be properly integrated and coordinated with other scientific fields. Furthermore, he must be able to rationalize his own technical data to meet the requirements of the ultimate objectives.

Population mobility, together with the decelerating influences affecting population growth, have added to the complexity of home-building programs. It is interesting to observe, however, that no one is questioning the desirability of better housing for the great masses of our people. The housing problems for agriculture are particularly acute, due to the increase in total number of farms and a long period of low income. In an industry of this sort rural housing involves both homes and production structures of many types, designed and so built to meet specific local requirements as to use, environment, and available building materials. In this field the agricultural engineer has already made an enviable record, particularly in better methods and materials of construction, and in cataloguing, through the various plan services of our agricultural colleges, farm structures of proven practical worth.

In the future I feel there will be less emphasis placed on this cataloguing type of work, first because there is not so much left to do, and, secondly, because new practices, new standards for production, new materials and improved fabricating methods will require systematic research for the new developments which seem inevitable. Environmental data, particularly in relation to specific uses and suitable building materials, are certain to be reckoned with more and more. For example, the introduction of ethylene gas as a means of advancing the harvesting season of English walnuts in certain production areas of California to improve quality of product, although in itself a relatively simple process has developed engineering questions of importance, such as: Should the gas be introduced in dosages or by a trickle system; what depth of bins should be used; how explosive is the gas at the concentrations used; what are the fire hazards; when should ventilation occur; what humidities are tolerated; what is the carbon dioxide tolerance; what facilities should be provided to handle unhulled nuts to prevent bruising? These and many other problems confront the engineer in attacking this particular problem which is typical, I believe, of numerous other problems to be met by the future agricultural engineer.

The domestic housing problems for agriculture involve homes for owners, tenants, and workers whether full-time or migratory. These are not so easily handled by the agricultural engineer because his basic training, generally speaking, has not included the artistry of architecture.

This requirement for rural-housing design, which seems to me quite essential for complete satisfaction, is not readily met by the engineer in agriculture. Perhaps we should confine our attention primarily to the basic functional re-

quirements of rural housing and then coordinate our work with the architects in a manner similar to our cooperation with biologists in farm production and processing problems. Thus far, farm home planning has not been attractive to professional architects, so the agricultural engineer, being a pioneer and recognizing the need of technical assistance, has shouldered the burden. I am looking forward to the time, which I hope will not be too far distant, when this branch of agricultural engineering service may enjoy more of the essential influence of an architectural service in keeping with agriculture's ability to pay.

The tendency now emphasized through national planning boards to concentrate production in the more favored areas should have a stabilizing effect upon agricultural populations. This should make it possible and profitable to give more attention to fire-resistant construction, and better planned and more centrally controlled utilities. This tendency toward closer settlement, however, is questioned by some. The Pacific Northwest Regional Planning Conference[5] held at Spokane, Washington, in February of this year, among other things stated, with reference to settlement, "We do not believe it is advisable to subdivide economic units or encourage close settlement of agricultural lands until industry has been developed to provide part-time employment and until increased local markets are available for agricultural products."

Rural areas, however, are being settled more closely. The number of farms in the United States is increasing rapidly. This makes it more necessary and desirable in our look ahead to think particularly of rural sewer and water districts to provide adequate and safe utilities. This work may not lie directly in the field of the agricultural engineer, but his experience and accumulated data acquired through years of engineering service to farmers, will be required in calculating services.

THE ENGINEERING FUTURE OF RURAL ELECTRIFICATION

Rural electrification holds an important place in our forward look. The issues of today, fortunately so far as we are directly concerned, are not directed primarily for or against rural electrical service, but upon the problems of ownership, whether public or private. It is not our function, in a meeting of this sort, to enter into controversial phases of such problems. It is sufficient for us to know that rural electrification is expanding. We must recognize, of course, that it is a type of service which basically is economic in nature.

Two important factors are involved in service extensions; first, the extent to which this service can be utilized on individual farms, and, secondly, the nature and extent of the area making up the base-rate territory. Of these two factors, the engineer is more concerned with the former. However, since economics enters into engineering calculations in arriving at justified production services, an interest in the latter is inescapable.

Basically, volume of use is an important factor in availability of rural service. This volume has certain limitations, due to the fact that electricity has not yet been able to meet competition on a practical basis for the energy demands for mobile farm power. For stationary uses, electricity is a versatile energy source for power, light, and heat. In the case of power and light there are a good many practical and economic limitations to control volume. In the case of heat, the volume for farm use is more promising if it can be supplied on a competitive basis. At present this seems doubtful. Thus area-volume use, as, for example, consumption per square mile, will be definitely influenced by population densities. Land-use planning should be helpful in this respect as it tends to encourage the optimum use and closer settlement of our best lands.

Many new farm uses for electricity are yet to be found, and there is ahead of us rich fields for investigation and research, which will contribute materially to rural-load building. The nature of the service as well as the industry served is such that we should be conscious of limiting factors in expansion in order to avoid extensions which cannot be self-liquidating. In drawing attention to this, the character of the area over which the rate base is spread is an important economic factor. If industrial and urban areas are conscious of the interdependency between rural and urban districts and are willing to share in a base-rate area, then the limits of service are defined primarily by the will of the people as a whole. This, of course, is a debatable economic question mostly outside of our profession but nevertheless one in which we, as engineers, are much interested.

Many have pointed to the high per capita consumption of electrical energy in the rural districts of California. This volume is due principally to irrigation pumping, a practice not possible or economically feasible on a majority of the farms of the nation. California conditions, therefore, should not be used as a criterion for volume of energy per farm. Here again we have limitations to consider. It is true that electricity when used for pumping, is translated into terms of water, which in turn is translated into crops; but even with an abundant supply of electrical energy, the program would be limited in California, as it is elsewhere, not by electricity or by land but by the available water supply, a practical limitation.

Electrical energy although highly desirable for the rural dweller involves regular payment of bills. Even a minimum of service requires the payment of monthly charges, and where larger volumes are used, larger payments are inevitable and must be met even though unit costs may be less. The philosophy of volume of use is after all basically economic, for volume depends upon ability to pay. It is essential, therefore, that farm customers should have sufficient income to meet at least the minimum requirements for service, which in turn must be of a sufficient total to justify the cost of service extension.

FACTORS OPERATING TO PREVENT A RURAL PEASANTRY

The thought of a rural peasantry in our nation seems out of harmony with our democratic form of government and unlikely of occurrence so long as we have our public school system, an inherent desire to do things better with less effort, a respect for our agricultural resources, and a desire for better home life. Surely our program of rural electrification is not predicated upon peasantry, but upon a continued scientific development of our countryside through intelligent farming and cooperative effort.

These factors working together as they do for rural progress, should be most heartening for agricultural engineers, for it is upon such factors that our professional future depends.

Let us consider for a few moments some of our own problems in effectively assuming the responsibilities which lie ahead of us. First of all, our service to agriculture calls for an engineering versatility much greater than is required in the older engineering professions of civil, electrical, and mechanical engineering. This (Continued on page 318)

[5]Land Policy Circular, Resettlement Administration, March 1936.

Recent Developments in Lumber Construction Applicable to Farm Building

By Frank P. Cartwright

THE AGRICULTURIST who is emerging from the depression years and beginning to consider new farm construction, must find himself somewhat in the situation of Rip Van Winkle. So many new ideas in building materials and their applications have been developed in the last few years that it is difficult in a brief presentation to give them more than passing mention. With the idea, therefore, of being as constructive as possible, this paper is confined to two important developments which should have wide and useful application in farm buildings, namely, the increasing use of plywood and the possibilities of timber connector construction.

The use of plywood not only for interiors, but also for sheathing and exterior finish on buildings, was dramatically emphasized by the all-wood house on display at the Century of Progress in Chicago during the period of that exposition. The difficulties experienced with plastic materials for interiors had long been recognized, and various products such as gypsum board and rigid fiber boards had been employed somewhat in low-cost buildings. By using these materials the builder avoided to a considerable extent unsightly cracks and settlements due to the flexibility of timber framing and the fragile character and excessive weight of plaster as an interior finish material. Their use also avoided the introduction into the structure of large amounts of moisture which made it difficult to secure accurate fit of sash and doors and sometimes involved difficulties with trim, flooring, and paint.

Plywood as a material for interior finish also has these advantages and is furthermore readily adaptable to use by farm builders. It is available in large sheets of all sizes and thicknesses and is very readily cut or sawn to meet the requirements of openings, trim, and irregularities in wall construction.

There has been in recent years a general recognition of the fact that plywood made with casein glue, or with the various types of resinoid (heat-set) glues, is not affected by atmospheric moisture and under ordinary use conditions is substantially a permanent material. The use of plywood in good residences is steadily on the increase and should be given thoughtful consideration by farm builders generally.

Presented before the Farm Structures Division of the American Society of Agricultural Engineers, at Chicago, December 2, 1935.

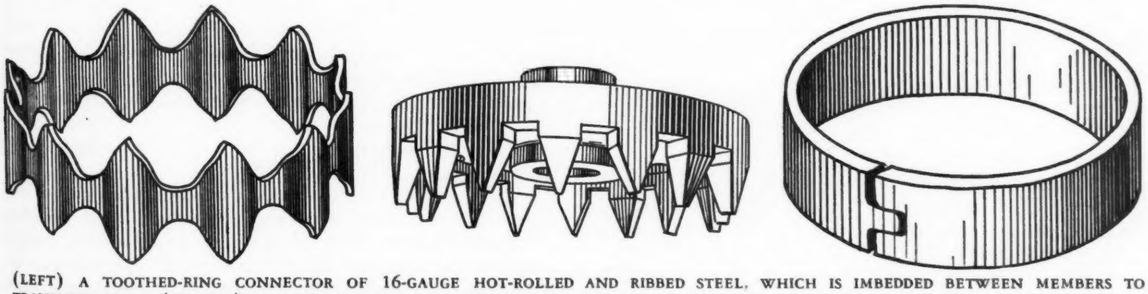
Author: Engineer, National Lumber Manufacturers Association.

Timber connector construction was introduced in the United States about three years ago through the agency of the U. S. Department of Commerce, which secured from European sources samples of the various types of connectors employed by them. These connectors were tested as regards load capacity by the USDA Forest Products Laboratory, and a publication describing their possibilities and applications was jointly issued by these agencies.

Since that time several types of connectors have become commercially available in this country, and their use for structures of all types has increased rapidly. Over seven thousand buildings and structures of various types have been built with them during the last two years, including roof trusses, tank towers, school buildings, assembly halls, piers, bridges, cooling towers, and other structures too numerous to mention.

A particularly interesting application of split-ring connectors from the viewpoint of farm construction is their use by the government in portable CCC camps. Over eighty linear miles of such buildings have been built during the last few months, the structures being made up of panels approximately 5 feet in width by 8 to 12 feet in length. The side joists of the roof panels were combined in an ingenious fashion with additional pieces to make up a simple Fink truss of 20-foot span. All connections were made with 2½-inch split rings. The construction proved so interesting to quartermaster corps officials in the fourth corps area that it was adapted by them for the building of a simple bungalow type of residence. Plans are now under way by the National Lumber Manufacturers Association to issue a series of leaflets illustrating the application of the CCC camp construction for portable dwellings, garages, tool sheds, and other types of buildings for farm purposes. A special type of tool has been developed for cutting the necessary grooves by hand, so that the builder will not require a portable motorized drill or electric power for the purpose.

The importance of timber connectors in timber framing may be judged from the fact that they increase load bearing capacity in structures such as mentioned above from 50 to 100 per cent. Design with timber as a material has in the past been limited by the strength of connections. Bolted connections were capable of developing on the average only from 50 to 60 per cent of the allowable working stresses in the members. It is possible in most cases with



(LEFT) A TOOTHED-RING CONNECTOR OF 16-GAUGE HOT-ROLLED AND RIBBED STEEL, WHICH IS IMBEDDED BETWEEN MEMBERS TO TRANSMIT LOADS. (CENTER) A MALLEABLE CASTING SHEAR-PLATE CONNECTOR FOR TRANSMITTING LOADS BETWEEN WOOD AND STEEL. (RIGHT) SMOOTH STEEL SPLIT-RING CONNECTOR FOR USE IN PRE-CUT GROOVES IN ADJOINING TIMBER FACES

timber connectors, to realize substantially the full allowable working stresses of the material and the result is that much greater load capacity can be developed with the same amount of material, or, conversely, the same loads can be provided for with a reduced footage.

The connectors now in use are of three types. Split ring connectors are plain steel rings made with a rectangular cross section and a tongued-and-grooved break in the perimeter.

For assembly of a split ring joint one or more bolt holes are bored in the timbers to be joined at points indicated on the plans. Circular grooves one-half the depth of the ring parallel to its axis are cut in the contacting surfaces of the timbers using a special grooving tool with a pilot which centers in the bolt hole already bored. The split ring is then placed in the groove in one timber, the other timber is fitted over it, and the joint is drawn tight with the bolt, which remains in the joint.

The break or "split" in this type of connector is made in the form of a tongued-and-grooved joint and is important. A solid ring, in transmitting loads, may bear against only the wood outside the groove, or only the wood core within. The split ring bears against both and therefore is able to transmit higher loads. In order to secure this double action regardless of the moisture content of the timbers at the time of installation, the diameter of the groove cut in each timber is made slightly greater than the diameter of the ring. When inserting the ring in the grooves it is, therefore, necessary to pry it apart; and the opening of the ring thus obtained at the split assures the double action at all times, either with dry or green timbers. The split in the ring should be placed nearest the edge of the member stressed parallel with the grain.

This type of connector is available in diameters of 2½ to 8 inches with working loads ranging from 1650 to 13,500 pounds depending on the species of timber used, the size of ring, and the inclination of load to the grain of the material.

Toothed ring connectors are sharp-toothed corrugated rings of sixteen-gauge sheet steel. When they are used in a joint, a bolt hole is bored through the assembly of lapped timbers, the members are lifted apart and toothed rings are placed between the adjacent faces of members to be connected. The members are then drawn tightly together by the bolt or other suitable means until the rings are completely imbedded in the wood, one-half the depth of each ring entering each adjacent member.

These connectors are commercially available in diameters from 2 to 4 inches with working loads ranging from 825 to 3500 pounds each, depending on the species and angle of load to the grain of the material.

The shear plate is a device for transferring loads from wood to steel and is also adaptable, in another form, to connections which are required to be readily demountable. It consists of a malleable iron circular plate with teeth arranged about the perimeter of one face, and a cylindrical hub on the opposite face concentric to a hole for the bolt which holds the assembly together.

The toothed face is partly fitted and partly imbedded in the timber until the outside face of the shear plate is flush with the surface of the wood. The projecting hub on the outside face fits into a hole in the steel plate or shape to which connection is to be made.

Shear plates are convenient for footing connections when a tension load must be transferred to anchor bolts, and in general for all situations where steel-to-wood connections are desired.

Working loads range from 2300 to 3200 pounds according to the inclination of load to grain.

Complete rules for design of timber structures with these devices have been developed and are given in a manual of timber connector construction available through the National Lumber Manufacturers Association.

Due possibly to the difficulties of publicizing such new developments in the farm construction field, there has been so far only limited applications of connectors in farm buildings. Several barns have been built with them and their utility for wide span roofs has been demonstrated.

Influence of Ultra Short Waves on Agricultural Plants

By J. W. Pincus

THE Ukraine Grain Institute and the Physico-Technical Institute of Dnepropetrovsk, U.S.S.R., in 1934 started experiments on treatment of cotton, cucumbers, tomatoes, and millet with ultra short waves. They noted quicker maturity and higher yields.

Tomatoes matured 11 days sooner on treated plants, cucumbers 9 days, and proso (millet) 2 to 3 days earlier. With cotton particularly telling results were obtained. The first bolls matured 27 days sooner, and in most plants the maturity was 10 days sooner. The number of bolls increased three times, and in one experiment, twenty times.

Tests were continued in 1935. Yields of best dosed plots of cotton increased 70 per cent. Some of the varieties of cotton started blooming 5 to 6 days sooner, and Egyptian cotton, 12 days sooner.

Tomatoes in 1935 bloomed 10 to 12 days sooner; castor oil beans, 3 to 8 days earlier. In addition to the experimental plots at the experiment stations more extensive experimental plots were started on the fields of the collective farms. Results here were also gratifying. Cotton seeds treated gave 3.38 to 6.40 centners more of cotton per hectare.

As a result of these favorable results, more than 5000 hectares of cotton will be planted with treated seeds in 1936. For the treatment of the seeds two stations were established, one at Melitopol and one at Genichensk. The Melitopol station is already fully equipped and in operation, and is probably the first station of its kind in the world. It has apparatus and equipment for treating at once five tons of cotton seeds and ten tons of castor oil beans.

The workers of these laboratories, who published brief results of their experiments recently in the Soviet papers, claim that the work of Academician T. D. Lysenko on phasic or stadial development of plants made them think of another approach to the influence of ultra short waves, and to radial energy as one of the forms of electro-magnetic energy.

In developing this theory, the authors state that the ultra short waves and other kinds of radial energy influence by transfering to the cells of plants a condensed energy. This causes activation of the life process. First it acts on energy of germination, and then on the hereditary influence of the protein hereditary base.

Author: Consulting agriculturist.

Well Battery Design

By Willard Gardner and Alton H. Peterson

IN THE BOTTOM of Cache Valley (Utah) there lies a large tract of land that is waterlogged because of artesian pressure in a gravel stratum lying near the surface.

In order to reclaim this land it seems to be necessary to relieve the pressure. The water is of good quality for irrigation. It has been proposed to pump large quantities and thus accomplish the double purpose of developing water and reclaiming the land.

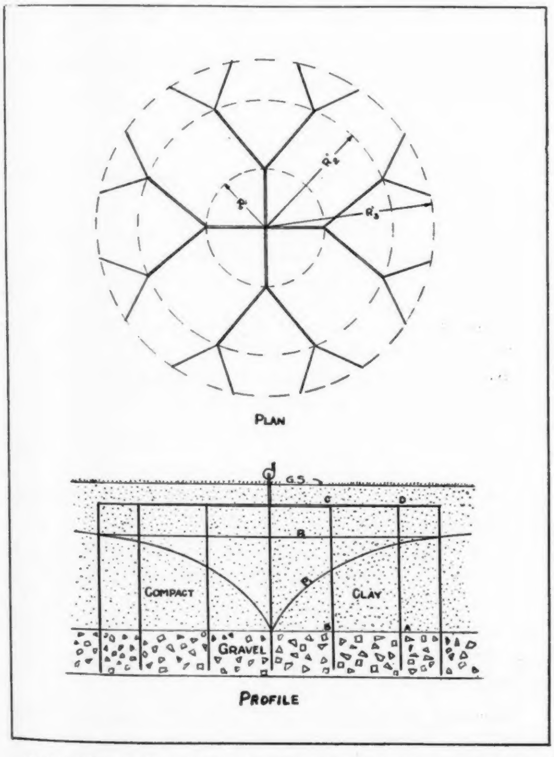
Studies have been made in the physics department at the Utah Agricultural Experiment Station which seem to indicate that a number of small wells connected to a common center will decrease the loss of energy due to friction in the water-bearing gravel and thereby increase efficiency in the use of power for pumping.

In a region such as this Cache Valley area it would be unnecessary to pump from great depths, and it is possible in the lower lands to siphon water from individual wells to a central pump.

Although elementary theory leads to the conclusion that a large number of small pipes should be used, difficulties, not taken into account, would be encountered in the use of extremely small pipes. The problem will be attacked therefore on the assumption that the radius of the vertical pipes is to be chosen arbitrarily and that they are distributed in such a way as to interconnect in a simple manner.

Contribution from department of physics, Utah Agricultural Experiment Station. Publication authorized April 2, 1936. First publication in AGRICULTURAL ENGINEERING.

Authors: Respectively, physicist and graduate assistant, department of physics, Utah Agricultural Experiment Station.



PLAN AND PROFILE SHOWING METHOD OF INTERCONNECTING SMALL WELLS

As a matter of theory it would be preferable to set down the cost per unit quantity of water pumped, z, as a function of all the independent variables, and then set equal to zero all the partial derivatives of z. Owing to the presence in the function, however, of quantities which depend in a more or less complicated way on the independent variables, a somewhat more direct and practical, though less rigorous, procedure will be followed.

In the choice of horizontal pipe to be used in connecting the small wells to the common center, it seems apparent that the cost of the pipe plus the cost of power consumed in friction should be independently minimized. It will be sufficiently accurate to assume a cost of pipe directly proportional to the product of the diameter and length, and that the friction loss, h_{fi}, per unit length may be represented to a sufficient degree of precision by means of the formula,

$$h_{fi} = \frac{kq_{hi}^2}{r_{hi}^5}, \qquad [1]$$

where k is a constant having the dimensions, L^5T^2/M^2; q_{hi} is the quantity of water per unit time flowing through the pipe, and r_{hi} is the radius of the pipe. The cost z_{hi} involved in carrying the water through the horizontal pipe from the i'th to the $(i-1)$'th circular array of small wells would be made up of two terms thus,

$$z_{hi} = \alpha r_{hi}\delta_i + \frac{(Pkq_{hi}^2)\,q_{hi}\delta_i}{r_{hi}^5}, \qquad [2]$$

the symbol α being a proportionality constant representing the capitalized cost per unit length of pipe of unit radius, δ_i the length of horizontal pipe carrying the water from the i'th to the $(i-1)$'th circular array, P a proportionality constant having the dimensions $\$T/ML$.

Differentiating the right-hand member of equation [2] with respect to r_{hi}, and equating to zero, treating q_{hi} as constant, leads to the result,

$$r_{hi}^6 = \frac{(5Pkq_{hi}^3)}{\alpha}. \qquad [3]$$

If we write v_{hi} for the velocity averaged over the cross section of the pipe and ρ for the density of the water, we may write the equation of continuity,

$$q_{hi} = \pi r_{hi}^2 \rho v_{hi}, \qquad [4]$$

and by this means eliminate r_{hi} and q_{hi} from equation [3], obtaining,

$$v_{hi}^3 = \frac{\alpha}{5Pk\pi^3\rho^3}. \qquad [5]$$

If we let m represent the number of circular arrays of small wells, it will be seen that there are available originally $4m + 2$ independent variables to be determined in perfecting the design. This includes m values r_{vi} and m values r_{hi} (representing the radii, respectively, of the vertical and horizontal pipes for the i'th circle of small wells), m values n_i (representing the number of small wells in the i'th array), m values δ_i, defined above, together with the depth H to which water is drawn in the central well, and the number of circles m itself. As stated, however, the m values r_{vi} will be taken as constant and the m values r_{hi} will be made to satisfy the m equations of type [3], leaving but $2m + 2$ independent variables. Inasmuch, also, as the diameter of the vertical pipes is to be chosen arbitrarily, it seems appropriate that the cost of these pipes plus cost of power should be minimized as in the case of the horizontal pipes. This would lead to m additional equations,

$$v_{vi}^3 = \frac{\beta}{5Pk\pi^3\rho^3}, \quad [6]$$

where β is a proportionality constant corresponding to α in equation [5].

It seems as a practical matter that the wells should interconnect in some such simple manner as is indicated in Fig. 1, the number of wells increasing in geometric progression in accordance with the formula,

$$n_i = 2^{i-1}n_1 \quad [7]$$

where n_1 satisfies the relation,

$$N = \sum_{i=1}^{i=m} (2^{i-1}n_1) + 1, \quad [8]$$

N representing the total number of small wells and the last term a single well at the center in addition to those in the circular arrays. With the r_{vi} being all taken equal to r_{vm} (the subscript, $_m$, being used to designate the outer circle) and the total flow Q being given, N may be obtained on the basis of the equation of continuity and equation [6], as follows,

$$Q = N r_{vm}^2 \left(\frac{\beta}{5Pk}\right)^{1/3}. \quad [9]$$

To choose Q arbitrarily will take away one degree of freedom, equations [6] will take away m, and equations [7] together with equation [8] will take away m more, leaving but one independent variable.

This remaining single degree of freedom will be utilized to minimize the total costs involved in moving the water from the m'th to the $(m-1)$'th circular array. Owing to the integral character of the n_i they can be varied only in finite steps. The cost terms affected by a variation $n_m q_{hm}$ in the flow from the water-bearing gravel to the horizontal pipes will consist of the cost, $n_m\alpha\delta_m r_{hm}$, of the n_m horizontal pipes of radius r_{hm} and of length δ_m; the cost of power required to drive the water through these pipes, $Ph_{fm}n_m q_{hm}\delta_m$; and the cost of power for friction loss in the gravel, $PH_{mo}Q$, H_{mo} being the friction loss in the gravel from the m'th to the $(m-1)$'th array before the variation. Corresponding to this finite variation $n_m q_{hm}$, there is a variation ΔH_{mo} in H_{mo}, and a variation Δr_{hm} ($=r_{hm}$) in r_{hm}. It is evident that two terms will arise from the variation in the term, $PH_{mo}Q$, and that ΔH_{mo} will be intrinsically negative when $n_m q_{hm}$ is intrinsically positive. Setting the sum of these variations equal to zero and dividing through by $n_m\delta_m$, we obtain

$$\alpha r_{hm} + Pq_{hm}h_{fm} - Pq_{hm}(H_m/\delta_m)_o + \frac{P(Q - n_m q_{hm})\Delta H_{mo}}{n_m\delta_m} = O. \quad [10]$$

On the basis of Darcy's law we may write,

$$Q = 2\pi R_m l\rho k'(H_m/\delta_m)_o \text{ and} \quad [11]$$

$$Q - n_m q_{hm} = 2\pi R_m l\rho k' [(H_m/\delta_m)_o + \Delta H_{mo}/\delta_m)], \quad [12]$$

where R_m is given approximately by the relation,

$$R_m = \sum_{i=1}^{i=m}\delta_i - \delta_m/2, \quad [13]$$

l representing the thickness of the water-bearing gravel stratum k' its transmission constant, and ρ the density of the water.

From equations [11] and [12] we deduce,

$$\frac{Q - (Q - n_m q_{hm})}{Q - n_m q_{hm}} = \frac{n_m q_{hm}}{Q - n_m q_{hm}} = \frac{-\Delta H_{mo}}{H_{mo} + \Delta H_{mo}}. \quad [14]$$

Eliminating ΔH_{mo} from [10] by means of [14] and solving for $(H_m/\delta_m)_o$ we obtain,

$$(H_m/\delta_m)_o = \frac{\alpha r_{hm}}{Pq_{hm}}. \quad [15]$$

This is to be interpreted, as will appear from the analysis, as an expression for the average loss in head per unit of distance in the water-bearing gravel from the m'th to the $(m-1)$'th circular array of wells before the reduction in flow due to the diversion of the quantity $n_m q_{hm}$ from the gravel to the horizontal pipes.

By means of the equation of continuity, equations [5] and [6] lead to the relation,

$$r_{hm}/r_{vm} = \sqrt{(\beta/\alpha)^{1/3}}. \quad [16]$$

Taking account also of equation [4] it is possible to reduce equation [15] to the form,

$$(H_m/\delta_m)_o = \frac{(25\alpha^5k^2)^{1/6}}{(P^4\beta)}(1/r_{vm}). \quad [17]$$

With r_{vm} and Q given this equation in connection with equation [11] will determine R_m.

Inasmuch as the friction loss for ABC must equal that for ADC it may be inferred that the loss from A to B in the gravel will equal that from C to D, h_{fm}, in the horizontal pipe, provided equation [6] holds for all vertical

pipes. We may therefore write again the equation of continuity.

$$2\pi R_m l \rho k' h_{fm} + n_m \pi r_{hm}^2 \rho v_{hm}$$
$$= 2\pi R_m l \rho k' (H_m/\delta_m)_o, \quad [18]$$

in which the factor $(H_m/\delta_m)_o$ is to be replaced by the right-hand member of equation [17]. By means of equations [1] and [5], h_{fm} and v_{hm} are determined in terms of r_{hm} and from equation [16] r_{hm} is known in terms of r_{vm}. Equation [18] may be used therefore to determine n_m in terms of the fundamental constants and Q and the arbitrary r_{vm}.

It should be observed that this result does not involve the assumption made in equation [7]. The value of n_m thus obtained should be modified, however, to give an integral value for m and integral values for the n_i, satisfying equation [8].

For given values of Q and r_{vm} equations [8] and [9] will suffice to determine m and all the n_i. Darcy's law would then give the equations,

$$2\pi R_i l \rho k' h_{fi} = (N - \sum_{j=i}^{j=m} n_j) q_{vm}, \quad [19]$$

where R_i has the same significance for the i'th array as does R_m for the m'th array, as defined in equation [13].

Finally, the radii, R_i', of the circular arrays are obtained with sufficient precision by means of the relation,

$$R_i' = R_i + \frac{R_i - R_{i-1}}{2}. \quad [20]$$

The values, r_{hi}, are obtained on the basis of the equation of continuity, thus,

$$n_i \pi r_{hi}^2 \rho v_{hi} = (\sum_{j=i}^{j=m} n_j) \pi r_{hm}^2 \rho v_{hm}. \quad [21]$$

Noting that $v_{hi} = v_{hm}$ and taking account of equation [16], this equation may be solved explicitly for r_{hi}, thus,

$$r_{hi} = \frac{(\sqrt{\sum_{j=i}^{j=m} n_j})(\beta/\alpha)^{1/6} r_{vm}}{n_i}. \quad [22]$$

In order to illustrate the computations the following numerical values have been chosen arbitrarily:

Q, the total flow, $= 2.85 \times 10^4$ cgs(centimeter-gram-second) units (corresponding to one cfs [cubic-foot-second]).

l, the thickness of the water bearing stratum, $= 457$ cm (centimeters) (or 15 feet).

k', the transmission constant of the gravel, $= 5$ g (grams) $\times 10^{-4}$ (corresponding to 5×10^{-4} in cgs units. It will be observed that the potential Φ has been expressed as a length in the analysis, giving a dimensionless number for the potential gradient, and therefore requiring the factor g $(=980)$ in obtaining k').

$2\alpha = \beta = 5 \times 10^{-11}$, the units being dollars divided by centimeters squared.

k, the pipe friction constant, $= 2.5 \times 10^{-6}$ (cm^5)/(sec^2 gm^2).

$P = 10^{-12}$ (dollars times seconds divided by grams times centimeters).

r_{vi}, the radius of the vertical pipes, $= 2.54$ cm (corresponding to 2-inch diameter pipe).

ρ, density of water, $= 1$ cgs unit.

The results obtained from these numerical magnitudes are tabulated as follows:

$N = 28$	$R_2' = 23$ feet
$m = 2$	$R_1' = 5$ feet
$n_2 = 18$	$r_{h2} = 2.85$ cm (2¼-inch diameter pipe)
$n_1 = 9$	$r_{h1} = 5$ cm (4-inch diameter pipe)
$n_0 = 1$	

As originally computed, the value of n_2 was 22.5 but 18 is the nearest integral number that will satisfy conditions expressed by equation [8]. The remaining quantities were based on this choice of n_2.

Holding Power of Nails

By A. J. Deniston, Jr.

THE DATA in this paper on the holding power of different types of nails may be of value to anyone interested in building construction work. Comparative tests were made of three types of 10-gauge nails: Screw shank nails, barbed nails, and smooth nails. They were driven two inches into blocks of dry, hard pine. Of 8 nails of each kind, five were withdrawn soon after having been driven, and three were left in the block, exposed to the weather and withdrawn 76 days later. The pull required to remove these nails is indicated in the table.

It will be observed that the average pull required to remove the 5 nails in the first test was 400 pounds, which is 85 per cent more than that required to pull the barbed nails and 34 per cent more than that required to pull the smooth nails. The maximum variation in pull between the high and low figures on the drive screw nail is 25 pounds; on the barbed nail, it is 50 pounds, and on the smooth nail, 100 pounds. The high variation in the case of the smooth nail is probably due to the fact that in some cases the fiber of the wood was cut by the points of the nail while in other cases the fibers were pressed apart.

	Screw Shank	Barbed	Smooth
	(Nails drawn soon after driving)		
	(lb)	(lb)	(lb)
	410	250	240
	405	210	305
	395	200	340
	400	210	305
	390	200	305
Average	400	216	299
	(Nails drawn after 76 days of exposure to weather)		
	480	60	30
	310 (wood split)	60	30
	310 (wood split)		35
Average	366⅔	60	31⅔

(Continued on page 320)

A contribution from the ASAE Committee on Commercial Building Materials (Subcommittee on Steel).

Author: President, The Deniston Company. Assoc. Mem. ASAE.

Aspects of Land Reclamation in Italy

By Augusto Alfani

THERE is a difference between what is understood by land reclamation in United States and what the term has come to mean in Italy. In the United States "reclamation" means essentially the improvement of land and control of water courses, the end in view being economic profit, sanitary advantages, or the conservation of natural resources. In Italy the purpose of land reclamation is different in many ways and is suggested by the qualification "integral".

The Italian reclamation works brought with them the solution of a vexing problem, the rapid absorption, during an acute stage of the depression, of idle men demanding bread and work, first as temporary laborers in the work of reclamation, later as permanent tenants on the reclaimed land.

Italy has an area of 110,500 square miles with a population of 44 million inhabitants, that is, a population almost one-third that of United States. By virtue of its physical and moral fiber and of the solid foundation of its home life, that population tends to increase steadily. It has, therefore, one-third of the United States' population concentrated on an area only a little larger than the state of Nevada. A high percentage of this area is mountainous and rocky, subject to a hot and arid climate with inadequate rainfall which, in the south, is so badly distributed that often not a drop falls for over three months.

In Italy the prevailing arrangement between farm labor and landowners is crop-sharing tenancy, which attains its most satisfactory form when the crop-sharing peasant and his family live on the farm. These families usually represent intelligent labor. They share the produce of the land generally on a 50-50 basis, with its owner, in whom we can see one exponent of capitalism.

The advancement of agriculture by intensive cultivation has been effected through the usual agencies: Agricultural courses and investigations of all grades, extension work, short-courses for farmers, and contests such as the "battle for wheat" and the "livestock breeding campaign." But they were not enough. Waste land must also be brought under cultivation and parcelled off so as to serve the interest and advantage not only of the individual, but also of the nation as a whole. Land never before exploited, even if of poor quality, must be made accessible and improved in order to consolidate and extend the territorial foundation of the fatherland.

HYDRAULICS IN RECLAMATION FOR INTENSIVE CULTIVATION

The all-important factor is hydraulic systematization: laying net-works of drain channels, pressing into service natural drains, filling and grading of land with inadequate natural fall. The solution of this problem has brought with it the necessity of regulating whole basins, especially where torrential streams rushing headlong from the upland emptied their waters onto the low-lying bottom. Solution of the problem has been effected mostly by the usual means resorted to in mountainous regions: soil consolidation, reforestation of bare hills, storage, diversion, and development of streams. Often recourse has been had to fillings, both in valleys and uplands, the transportation of earth being effected either through the agency of water or by mechanical means. Where, in the upland, some clay formations affected by sheet and gulley erosion at the same time rendered the consolidation of soil by means of reforestation difficult or anti-economic, it has been consolidated by means of a special grass and thus set aside for farming instead of being turned into a woodland. Some marshes lying beyond the farming zones and bordering on the sea have been utilized either for pisciculture or for the extraction of sodium chloride. The reclamation work is always carried out in conformity with the rules laid down by medical science to eradicate residual malaria.

Within the province of hydraulics fall also the various reclamation efforts, including irrigation from large canals fed by important streams or upland basins. In the latter case, electric power is a primary product. Within the same province fall likewise the gigantic projects undertaken to supply whole regions with drinking water, a work which has proven very beneficial to the progress of reclamation.

Some districts could hardly be cultivated by reason of the texture of their soil. An extremely compact, deep substratum, the "tufe" or tuff of the Agro Romano lay beneath a normal thin top layer. These districts, formerly with negligible wheat production and used mostly as grazing ground for seasonal transient herds, have been transformed into flourishing wheat-producing and dairy farm lands by means of deep rope-traction plowing. Immediately after plowing, the large tufa clods were broken up into small pieces and left to disintegrate under the action of climatic changes. The result was an excellent farming soil.

RECLAMATION OF LAND FROM METHODS AND PRACTICES BACKED BY CENTURIES OF TRADITION

In some districts lacking adequate road facilities the reclamation work has consisted mainly in laying a network of roads. In still other districts the relation between the "latifundia," large estates farmed out by their absentee owners, and farm labor was such as to keep agriculture in a backward stage and injure the interest of the country at large. It was necessary to facilitate and intensify the cultivation of such estates by the introduction of modern farming methods, by getting the peasant closer to his field, by setting him and his family there and securing for him fairer wages. New rural towns and hamlets sprang up and farmsteads now dot the once deserted countryside.

These are the main aspects of the physical problem of reclamation. But the case involving only one problem has been rare. Generally the problems dovetailed and interlocked; their solution created new and more complex but unsuspected problems.

Once the reclamation of a district has been decided upon, it has been undertaken and carried out thoroughly and comprehensively, leaving no gaps which might jeopardize the fullest agricultural use of the district reclaimed. If often the solution of the problems presented by the physical aspect of the project has been difficult, equally difficult has been the solution of those arising from the most disparate rights and privileges, vested and consolidated through centuries of history. Therefore, in this field it was necessary also to discard decrepit, un- *(Continued on page 320)*

Author: Graduate student in agricultural engineering, Rutgers University, 1935-1936, and doctor of agriculture, University of Florence, Italy.

Brown Type Multistage Walnut Dehydrator

By B. D. Moses

EXPERIENCE has shown that in order for the walnut grower to produce the greatest quantity of high quality nuts he must dry them artificially. Several types of dehydrators have been developed, mostly in California, making use of the principle of blowing heated air through nuts held in some kind of bin or container. Recently W. G. Brown, an engineer of Portland, Oregon, who also raises walnuts, developed a dehydrator that attracted the attention of a California grower, Ray Miller, of Linden, and he built one. Because of the success he had, other California growers became interested and H. B. Walker, of the University of California, was called into a conference, with the result that an experimental plant was designed and built by A. J. Thille, of Santa Paul.

Mr. Thille built a frame structure approximately 10 feet square and 20 feet high divided into four 5-by-5-foot stacks. Each stack is divided into six compartments, the top four forming bins for holding the nuts during drying. The bottom compartment is for receiving air from a blower and distributing it to the stacks. There is a "sacking out" hopper between the air chamber and the drying bins. The drying bins are provided with dumping grates built of hardware cloth on wooden frames in such a manner that, when they are closed, the air can pass upward through the nuts, and when open, the nuts flow downward into the next bin below.

As drying progresses the nuts are dropped successively from the top bin to the second, third, and bottom at intervals of 5 to 9 hours depending on conditions. In this manner the wettest, coldest nuts come in contact with the wettest, coldest air, and the dryest, hottest nuts come in contact with the dryest, hottest air.

An opportunity presented itself this last fall to observe Mr. Thille's plant in operation but before going into the data taken it will be well to recall some of the conditions and constants which have been used up to the present time:

1 The maximum temperature to which English walnuts should be heated has been set at 110 degrees (Fahrenheit).

2 The moisture content of nuts from the field varies between 25 and 35 per cent of the wet weight.

3 The dried nut contains 8 to 10 per cent moisture.

4 The pressure drop, through nuts, of air having a velocity equivalent of 100 cubic feet per minute per square foot of bin area is variously estimated at 1/12 to ⅛-inch of water per foot depth of nuts.

5 Practical velocities in cubic feet per minute per square foot of bin area, have been variously estimated at from 75 to 600. It seems that probably 150 to 200 cubic feet will prove the most practical.

6 Temperature of nuts when received varies from 60 to 90 degrees.

7 Dried nuts contain 8 to 10 per cent water and weigh approximately 20 pounds per cubic foot.

8 Wet nuts from the field will weigh 28 to 30 pounds per cubic foot.

During the observations made on Mr. Thille's dehydrator an effort was made to obtain the temperatures in the nut masses in the different bins during drying—the wet and dry bulb readings above the nuts in each bin, particularly just before dumping; the moisture content of the nuts in each bin at time of dumping; the gas and electricity used; air velocities and general weather and operating conditions.

Altogether there were twenty-three lots of nuts dried, averaging about twenty sacks, or 1100 pounds to the lot, upon which more or less complete records were kept. A tabulation of the nut temperatures showed that for bin No 1 (top) there was sometimes a rise in temperature of 7 degrees, and there was also an occasional drop of nearly as many degrees; the second bin showed a decided tendency to warm up, changing as much as 29 degrees in one instance and frequently more than 20 degrees; bin No 3, the next to the bottom, warmed up but somewhat less than was found to be the case in No 2, while the bottom bin warmed still less. The average rise for all the lots was 1.2 degrees for the top, or No 1; 14 degrees for the next, or No 2; 11 degrees for the next, or No 3; and 9 degrees for the next or bottom bin.

Fig. 1 shows the nut temperatures and per cent of water in the nuts throughout the drying process.

Ninety samples were taken for moisture determination and overall averages gave moisture contents of nuts going into No. 1, 29.4 per cent; out of No. 1, 29.4 per cent; out of No 2, 21.4 per cent; out of No 3, 15.9 per cent, and out of No 4, 9.7 per cent.

The wet-and-dry bulb temperatures taken above the nuts just before they were dumped brought out an interesting relation between nut moisture and the relative humidity of the air. The average relative humidities were found to be 84 per cent in top bin; 67 per cent in second bin; 40 per cent in the third; and 27 per cent in the fourth.

For the velocity of air maintained in this dehydrator, 100 to 125 feet per minute, a quite definite relation existed between the nut moisture content and the relative humidity of the air directly above them. In fact, the correlation was so true that the wet bulb reading could be taken as an index to the dryness of the nuts (Fig. 2).

Fig. 3 exhibits what was taking place for each of eight lots dried in one of the stacks. The points brought out

Presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, January 10 and 11, 1936.

Author: Associate agricultural engineer, University of California. Mem. ASAE.

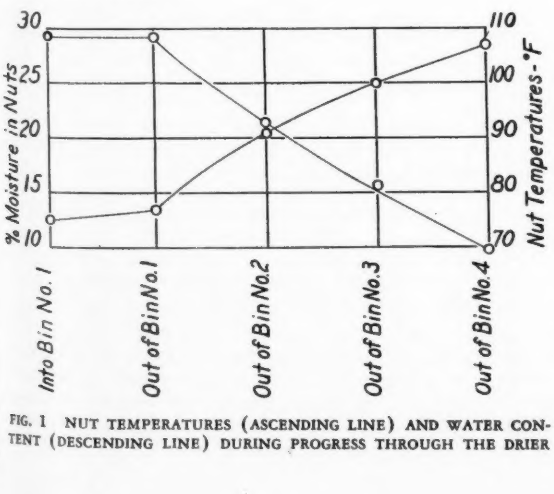


FIG. 1 NUT TEMPERATURES (ASCENDING LINE) AND WATER CONTENT (DESCENDING LINE) DURING PROGRESS THROUGH THE DRIER

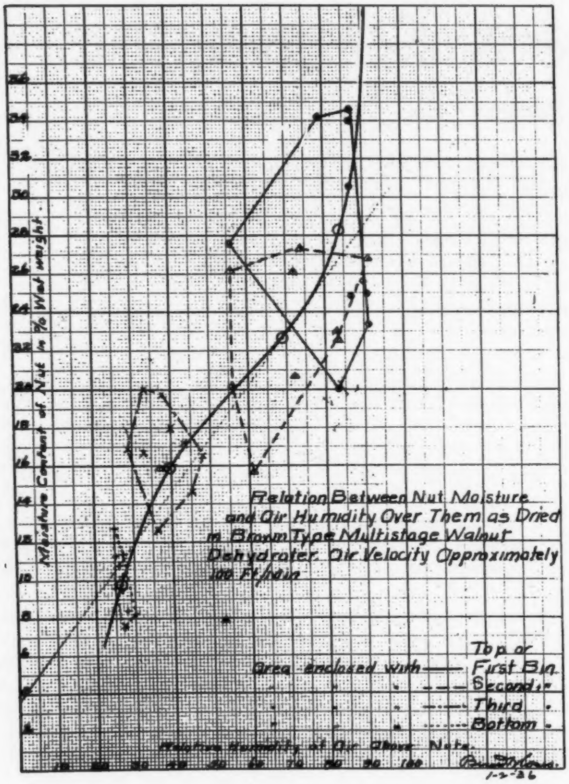


FIG. 2 RELATION BETWEEN NUT MOISTURE AND AIR ABOVE THE NUTS IN EACH STAGE OF THE DRYER

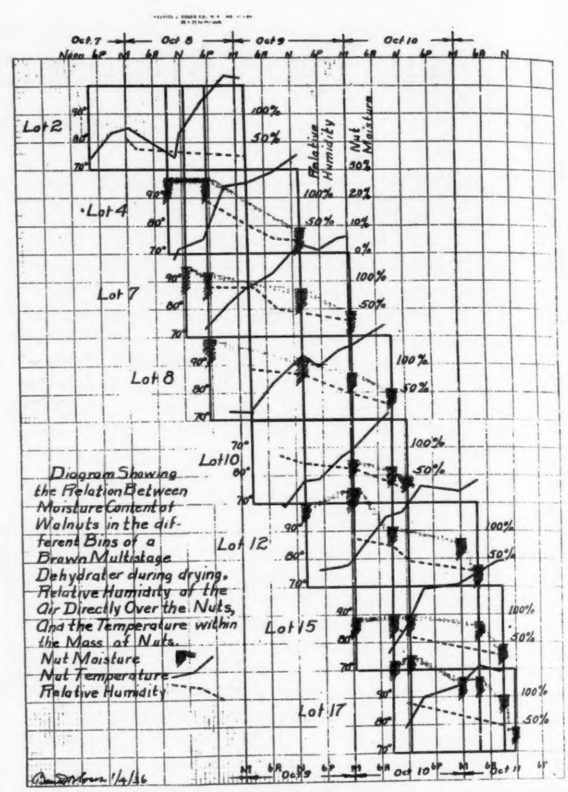


FIG. 3 NUT MOISTURE, TEMPERATURE AND AIR HUMIDITY BY LOT DURING DRYING AND AS TO SIMULTANEOUS CONDITIONS IN THE SEVERAL STAGES OF THE DRIER

above can be easily checked either by tracing each lot from left to right or the simultaneous condition of one bin by tracing the bins from top to bottom of the chart.

The fuel consumed, as shown by Mr. Thille's gas bill, was 184,200 cubic feet of gas for drying 148.5 tons, or an average of 1240 cubic feet per ton. Readings taken during the time the dehydrator was under observation showed that it required an average of 1195 cubic feet per sack per hour. Assuming an average drying time of 30 hours and assuming 36 sacks per ton of dried nuts, this would give 1269 cubic feet per ton, in round numbers a heat requirement of 1,400,000 Btu per ton. Mr. Thille's furnace was quite efficient because it discharged the burnt gases through the blower and thence through the nuts. When oil is used as a fuel, the burnt gases cannot be passed through the nuts and the efficiency will be reduced 35 to 40 per cent, raising the fuel requirement nearer to 2,300,000 Btu per ton.

A discussion of the dehydrator would be incomplete without some reference to the quality of the nuts dried. Mr. Thille had an interesting experience. The bins in one stack were all filled at once and the dehydrator set in operation. The following is a tabulation of the results:

Bin No.	Time to dry, hr	Per cent light meats
1	35	31
2	29½	53
3	23¼	53
4	15½	77

M. H. Kimball, of the farm advisor's office of Los Angeles, ran samples of nuts through the Brown dehydrator, through another type of bin dehydrator, and in a separate drying chamber. The differences in quality was not significant.

Sled Train Sprinkler Is Market Garden Aid

A FEW wooden sleds, about 600 feet of galvanized steel wire, some nails or wooden blocks, a 200-foot length of 1-inch galvanized iron pipe—these are the makings of a low-cost portable sprinkler for irrigating low-growing crops. It is simple to make, and the outfit can be moved by one man and one horse, says F. E. Staebner, of the U. S. Bureau of Agricultural Engineering, who designed it. The system is especially adapted to long narrow fields in humid regions and does not seriously interfere with cultivation.

Wooden sleds about 8 inches high are spaced 15 feet apart for the length of the pipe and carry it the length of the field. They are connected with two No. 9 galvanized steel wires passed along the length of the train and fastened to the sides of each sled. At each end of the train, the ends of the two long wires are brought together and looped through the ring of the single tree and held in place by a wooden block. The 200-foot pipe, with holes drilled about 3 feet apart and equipped with nozzles, is laid on the tops of the sleds and is held in place with nails or wooden blocks. A good horse or a tractor can easily draw the train of sleds and pipe back and forth.

A Theory of Arch Action in Granular Media

By Ralph D. Doner

IT IS WELL KNOWN that the force reactions produced by any implement or surface disturbing the soil are distributed through a considerable mass. The laws governing this arching out of the force are very important in wheel and implement design as they determine in a large part the draft of the implement and the effect on the soil. During the last few years a large amount of experimental data on arch action and compression resistance of soils has been gathered by M. L. Nichols of the agricultural engineering department, Alabama Agricultural Experiment Station. While these data quite clearly show the general nature of the soil's reactions, there remains the necessity of finding a clear and satisfactory interpretation through a theoretical approach.

This paper sets forth in the form of a theory the mathematically derived laws involved in an explanation of arch action. Frequent checking of theory with data was made throughout this development and indicated that the two were essentially in accord.

The development of this theory parallels somewhat that of the kinetic theory of gases. Each was preceded by experimental knowledge lacking in coordination, and each proceeds from the particular to the general, from the atom or particle to the mass, by means of logical steps.

Just as the theory of hydrodynamics applies to all liquids in general, and aerodynamics to all matter in the gaseous state, it is believed that the laws derived in this paper apply to all matter in the granular state, such as cereal grains, powders, gravel, soils and the like.

These laws give the contributions to a field of force made by differential elements of a disturbing surface, and hence serve as mathematical tools for calculating the whole field of force caused by any definite disturbances. A simplified technique for applying these rather complicated tools to conventional implements has not yet been developed but should not prove to be too difficult.

FUNDAMENTAL PROPERTIES OF SOIL

Nichols[1] gives the formula

$$F_s = \frac{0.06M}{P1}(Pn + 20) + P + 0.6$$

relating the force required to produce shear (F_s) to pressure (P) and moisture content and plasticity constants of the soil. By writing

$$C = \frac{0.06M}{P1}(Pn + 20) + 0.6$$

this formula becomes (for any given soil at constant moisture)

$$F = 1.0\ (P + C)$$

where 1.0 is the coefficient of shear.

Define s as the coefficient of shear for granular media in general. Then

$$F_s = s\ (P + C)$$

Written in this form the equation is subject to the following interpretation: P is the external or applied normal force; C is the internal cohesive normal force, definitely related to the moisture properties of the medium; s is the coefficient of shear or internal friction related to the shape and surface properties of the average particle; and F_s is the tangential force required to produce shearing motion. Cohesion C and shear s are distinctly quantitative characteristics of the medium, being averages of the normal and tangential reactions of individual particles at points of contact. Although these in turn have been found to be related to such factors as colloidal content and the like, just as pressure and temperature constants of gases are related to molecular weight and velocity, it would be impractical to base laws governing gross reactions on any properties less directly measurable than cohesion and shear.

In any theory dealing with the transmission of force and energy through space the mechanism by which this transmission is effected plays an important role. If the space is occupied by matter, the units of matter furnish the mechanism; if not, ideal units such as lines of force are postulated.

In view of these considerations, cohesion and shear ratios were selected as the basis of this theory. All soils that are practically free of roots, trash, rocks, and other foreign matter are considered as granular media.

GRANULAR MEDIA

The essential features of a granular medium may be defined as follows:

1 *Composition.* A granular medium is composed of solid granular particles varying in shape, size, and material within a range such that all gross samples are essentially alike.

2 *Compressibility.* The density or apparent specific gravity of a granular medium varies from that assumed when loosely packed by its own weight, to a maximum attained by rearrangement of particles through slipping without crushing due to a relatively large external force. This specifies chaotic rather than ordered structural arrangement.

3 *Cohesion.* The cohesive force due to moisture films between particles may vary from zero, for no films, through a positive range for concave films and possibly back to negative cohesion or repulsion for convex films. A soil ceases to be a granular medium as here defined when it shows plastic properties. For some types of granular media, such as cereal grains in their normal state, the cohesive force is zero.

4 *Shear.* A coefficient of shear or internal friction of particle on particle is defined as the force per unit width necessary to shear unit surface in the dry medium under unit normal pressure.

First publication in AGRICULTURAL ENGINEERING by permission of the Director of the Alabama Agricultural Experiment Station and the Chief of the USDA Bureau of Agricultural Engineering.

Author: Collaborator, department of agricultural engineering, Alabama Polytechnic Institute and division of mechanical equipment, USDA Bureau of Agricultural Engineering.

[1] "The Dynamic Properties of Soils, III, Shear Values of Uncemented Soils," by M. L. Nichols, AGRICULTURAL ENGINEERING, vol. 13, no. 8, August 1932.

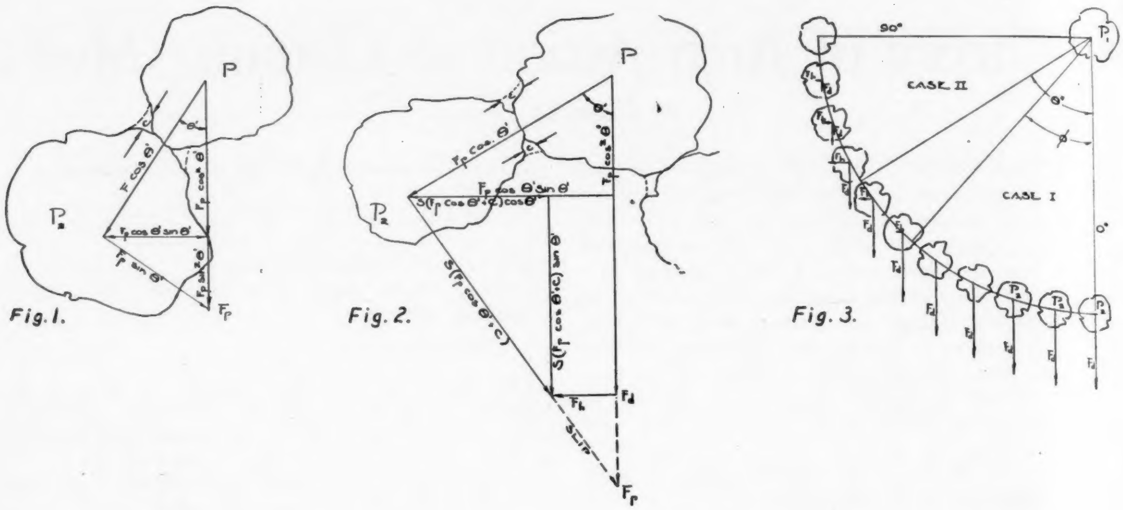


FIG. 1 (LEFT) FORCE DIAGRAM FOR CASE I. FIG. 2 (CENTER) FORCE DIAGRAM FOR CASE II. FIG. 3 (RIGHT) DIAGRAM SHOWING EFFECT OF Θ' AND ϕ'', F_d AND F_h

THE DYNAMICS OF A TYPICAL PARTICLE

For convenience of reference, the symbols used are listed and defined as follows:

F_t = the force per unit width tangent to a surface of contact.

F_n = the total normal force per unit area.

C = the cohesive or internal normal force per unit area.

s = the coefficient of shear of dry media.

F_p = the downward force per unit area exerted by a particle P (Figs. 1 and 2).

F_d = the downward force per unit area given to a second particle P_2 by P.

F_h = the horizontal force per unit area give to P_2 by P.

Θ' = the angle between the vertical and the line PP_2 (the normal to surfaces at point of contact).

F_c = the total horizontal force or cross-pressure per unit area caused by F_p

$\overline{F}_d$ = the average value of F_d over the full range of values possible for Θ'.

$\overline{F}_h$ = the average value of F_h over the same range.

$R = C/F_p$ the ratio of internal to external force.

Particle P, Figs. 1 and 2, is a typical particle in the medium supported by those below. P_2 is one of several affording this support. (In what follows every force should be divided by the number of contacts per unit area. However, since this factor cancels out of every equation, it is omitted). Two types of reactions are possible, designated as Case I and Case II. In Case I no slipping takes place between P and P_2, while in Case II slipping does occur. Slipping will not occur if F_t is less than $s \times F_n$, and will occur if F_t is greater than $s \times F_n$. But $F_t = F_p \sin\Theta'$, and $F_n = F_p \cos\Theta' + C$. Hence for Case I,

$$F_p \sin\Theta' < s(F_p\cos\Theta' + C),$$

And for Case II,

$$F_p\sin\Theta' > s(F_p\cos\Theta' + C).$$

The effect on P_2 for Case I is found by resolving $F_p\cos\Theta'$ and $F_p\sin\Theta'$ into their vertical and horizontal components and combining. For Case II, $F_p\cos\Theta'$ and $s(F_p\cos\Theta' + C)$ are similarly treated. Thus;

$$\text{Case I}\begin{cases} F_d = F_p \cos^2\Theta' + F_p \sin^2\Theta' = F_p & [1] \\ F_h = F_p \cos\Theta' \sin\Theta' - F_p \sin\Theta' \cos\Theta' = 0, & [2] \end{cases}$$

$$\text{Case II}\begin{cases} F_d = F_p \cos^2\Theta' + s(F_p \cos\Theta' + C) \sin\Theta', & [3] \\ F_h = F_p \cos\Theta' \sin\Theta' - s(F_p \cos\Theta' + C) \cos\Theta'. & [4] \end{cases}$$

Case II begins at that value of $\Theta' = \phi$ which satisfies the equation

$$F_p \sin\phi = s(F_p \cos\phi + C). \qquad [5]$$

This may be written in the form

$$\cos\phi = \frac{\sqrt{1 + s^2 (1-R^2)} - s^2 R}{1 + s^2} \qquad [6]$$

Case II may be shown to end at 90 degrees, ($\pi/2$ radians). For every arrangement in which P derives support from P_2 at an angle greater than $\pi/2$ radians, (due to cohesion C) there is a symmetrical arrangement in which P gives support to P_2 at an angle less than $\pi/2$ radians. That is, what is incorrectly included below $\pi/2$ as support is offset by what is omitted beyond $\pi/2$. Fig. 3 illustrates the effect of Θ' and ϕ on F_d and F_h.

To find the value of $\overline{F}_d$ over the range 0 to 90 degrees requires first, finding the average value of F_d over the range 0 degrees to ϕ; second, over the range ϕ to 90 degrees; third, weighting these averages by their respective ranges; and fourth, averaging these weighted averages. From equation [1], $F_d = F_p$ from 0 to ϕ. By use of equation [3], F_d has the average value

$$\frac{1}{\pi/2 - \phi}\int_{\phi}^{\pi/2} [F_p \cos^2\Theta' + s\,(F_p \cos\Theta' + C) \sin\Theta']\, d\Theta'$$

over the range ϕ to $\pi/2$. Multiplying by the range, averaging, and simplifying gives

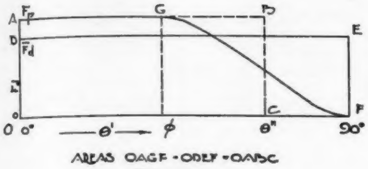


Fig. 5.

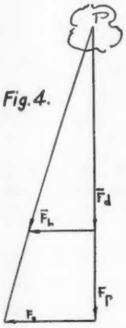


Fig. 4.

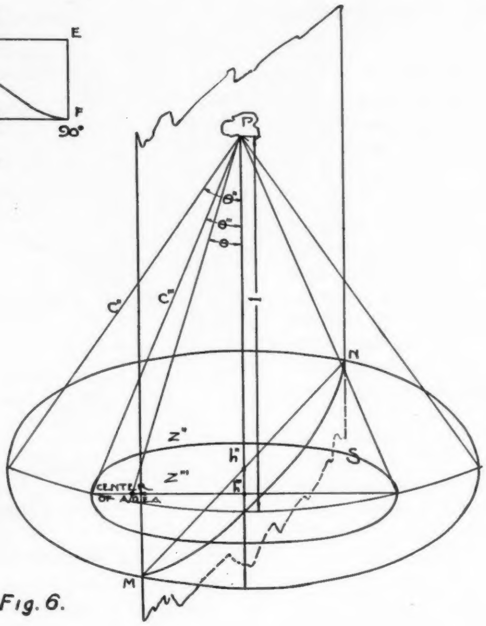


Fig. 6.

FIG. 4 (LOWER LEFT) DIAGRAM SHOWING THE RELATION $F_c/F_p = \overline{F}_h/\overline{F}_d$

FIG. 5 (UPPER LEFT) RELATIONSHIP OF F_d, $\overline{F}_d$ AND $0''$ WITH Θ' AND ϕ

FIG. 6 (RIGHT) CENTER OF AREA OF HALF ZONE Z''

$$\overline{F}_d = \frac{2F_p}{\pi}\left[\phi + \int_{\phi}^{\pi/2} (\cos^2\Theta' + s\sin\Theta'\cos\Theta' + sR\sin\Theta')\,d\Theta'\right]. \qquad [7]$$

A similar treatment for F_h gives

$$\overline{F}_h = \frac{2F_p}{\pi}\left[0 + \int_{\phi}^{\pi/2} (\sin\Theta'\cos\Theta' - s\cos^2\Theta' - sR\cos\Theta')\,d\Theta'\right]. \qquad [8]$$

Integrating, substituting limits, and simplifying,

$$\overline{F}_d = F_p\ (\phi + \pi/2 + sR\cos\phi)\ /\pi \qquad [9]$$

$$\overline{F}_h = F_p\ (1 - s\pi/2 + s\phi - 2sR + sR\sin\phi)\ /\pi \qquad [10]$$

In transmitting F_p downward to particles below P gives P_2 on the average $\overline{F}_d$ downward and $\overline{F}_h$ horizontally. Consequently other particles must share in the distribution of F_p. The total cross-pressure F_c must be in the same ratio to F_p as $\overline{F}_h$ is to $\overline{F}_d$, that is, (see Fig. 4)

$$F_c = F_p \times \overline{F}_h/\overline{F}_d \qquad [11]$$

The assumption of chaotic arrangement in the medium is equivalent to the assumption that any value of Θ' from 0 to $\pi/2$ is equally probable. Also, equations [3] and [4] may be considered as expressing the probability of F_d and F_h being propagated at such an angle. This furnishes a basis for calculating the probability of these forces reaching a point at any particular angle after a sequence of transmissions along a chain of particles. A simple method of arriving at approximately the same result consists in replacing partial support $\overline{F}_d$ over the full range 0 degree to $\pi/2$ by full support F_p over a reducer range 0 degree to Θ'', that is, (see Fig. 5.)

$$\overline{F}_d \times \pi/2 = F_p \times \Theta''.$$

$$\text{Hence } \Theta'' = (\pi/2) \times (\overline{F}_d/F_p). \qquad [12]$$

Some knowledge of the average number of particles supporting P is required for the next step in finding the manner in which this support is distributed. From purely geometrical considerations this number is between one and three. Detailed calculations based on the assumption that the number is 1.5, 2.0, or 2.5 indicate that very little variation results as far as the rate of spreading out or "arching" of support is concerned. It is permissible, therefore, to take two as the average number of particles supporting P actively.

Let S (see Fig. 6) be a sphere of unit radius and center at P, and C'' a cone, vertex at P and generating angle Θ''. Let Z be the area of the zone cut by C'' on S. Bisect Z by a vertical plane PMN. On the average there will be one particle P_2 in each half zone. Any point on the half zone is equally probable for the direction of P_2 from P. Then the center of area of this half zone locates the direction away from the plane PMN, outside of which the support tends to vanish as the distance from P increases, and inside of this direction the support is distributed according to some law. Since the areas of spherical zones are proportional to their altitudes, this direction lies away from the vertical by an angle Θ''' given by

$$\cos\Theta''' = 1/2\ (1 + \cos\Theta'') \qquad [13]$$

This angle Θ''' is the generating angle of a second cone C''' bisecting zone Z. Thus C''' traces a circle on the sphere S. Then the center of gravity of half this circle is the center of area of the half zone, and its direction Θ away from the vertical is given by

$$\tan\Theta = 2/\pi\ \tan\Theta''' \qquad [14]$$

Both Θ and F_c/F_p are functions of s and R alone. These relationships are shown in Graphs 1 and 2. Θ will be of

importance below in bounding the arch, and will be called the arching angle.

DYNAMICS OF MORE THAN ONE PARTICLE

Consider a horizontal row of particles P, P', P'', etc., in the plane PMN. Their supporting cones are bounded by two planes passing through the row of particles and making angles $+\Theta$ and $-\Theta$ with the vertical. Thus Θ serves in generalizing from a single particle to a row of particles.

In order to generalize further to a band or strip of particles, it is necessary to consider the ability of a particle to receive forces from those above it. Obviously it may receive through the same agencies by which it may transmit, hence an inverted cone with a generating angle Θ encloses that part of the medium from which it may receive downward forces. In Fig. 7, Q is a portion of the strip of particles. From its edges planes M, N, M' and N' are drawn making angles $+\Theta$ and $-\Theta$ with the vertical. Thus the supporting region is divided into four sub-regions A, B, B', and C. Suppose P to be in region B. Its cone intercepts the area L on Q. A set of coordinate axes may be taken with the origin at the surface of the medium, the x axis positive to the left, and the y axis positive downward passing through the center of Q. Let y' represent the distance from the origin to Q, and $2a$ the width of Q. Then the coordinates of P are (x,y), the altitude of the cone is $(y\text{-}y')$, and the radius of the base is $(y\text{-}y')\tan\Theta = r$.

Let W be the pressure per unit area on Q, and W_1 the initial pressure or bearing power throughout the medium. It follows that the pressure W_b at P is to W as L is to the area of the base, πr^2, with some correction factor applied to take into account the distance from the center of L to the center of the circle. Solving for W_b,

$$W_b = W\ (L/\pi r^2) \times K$$

For the case where the medium is very nearly imcompressible and under very high pressure, K takes the form[2] $\cos^n B$, where $B = (x\text{-}a/r)$ 90 degrees. But for the case where the medium is compressible, experiments indicate that the freedom of motion and readjustment tend to equalize the pressure to such an extent that the exponent n is nearly zero, making K practically equal to one. It will be shown later that to take $K = 1$ is logical. Hence

$$W_a,\ W_b, \text{ or } W_c = WL/\pi r^2 \qquad [15]$$

Applying this formula to a particle located in region A gives

$$W_a = W. \qquad [16]$$

Similarly,

$$W_b = W\ (2\beta - \sin 2\beta)/2\pi \qquad [17]$$

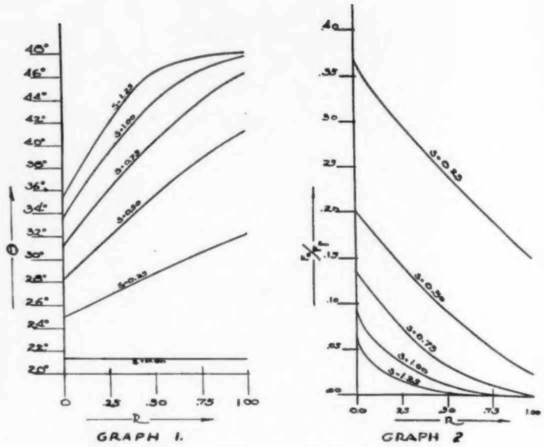
$$W_c = W(2\beta - 2\beta' - \sin 2\beta + \sin 2\beta')/2\pi \qquad [18]$$

where 2β is the angle subtended at the center of the base of the cone by the left edge of Q and $2\beta'$ the angle subtended by the right edge.

At any general distance $(y\text{-}y')$ below Q these expressions must account for the total load on Q. If Q is indefinitely long, a cross-section of unit width may be taken as typical and the sum of pressures from M to M' becomes

$$2\int_{O}^{r-a} W_c\, dx + 2\int_{r-a}^{r+a} W_b\, dx = 2aW \qquad [19]$$

[2] "Dynamics of Earth and Other Macroscopic Matter," by John L. Griffith, Iowa State College Bulletin No. 46.



GRAPH 1 (LEFT) ARCHING ANGLE AS A FUNCTION OF S AND R. GRAPH 2 (RIGHT) RATIO OF CROSS PRESSURE TO DOWNWARD PRESSURE AS A FUNCTION OF S AND R

This is verified by performing the indicated integrations.

The strip Q may be regarded as the layer of particles immediately under the face of a plunger causing a localized disturbance in the medium. Then equations [16], [17] and [18] give the distribution of downward pressures in the supporting arch. Equation [10] gives the cross pressure, and the resultant of the two gives the total pressure in direction of magnitude. The horizontal gradient of the cross pressure gives the force tending to move the particles in that direction and is found by evaluating $\partial F_c/\partial x$. It is most active in region B near the edge of the plunger. The rate of shearing is given by ∂W_c or $\partial W_b/\partial x$ and is most active in region B also.

Suppose now that the width of the plunger $2a$ is the diameter of a typical particle. At a considerable depth the pressures W_b and W_c may be plotted against x. Divide these by the number of particles (that is, by the length of chord Q cuts on the base of the cone in Fig. 7) causing each particular pressure. This result represents the contribution per particle in Q, and proves to be very nearly constant. Hence the assumption above that a particle transmits forces equally in all directions inside the supporting cone is logical. Before the relationship between depth of sinking in y' of the plunger and the pressure W can be deduced, it is necessary to know the general law of compression for granular media.

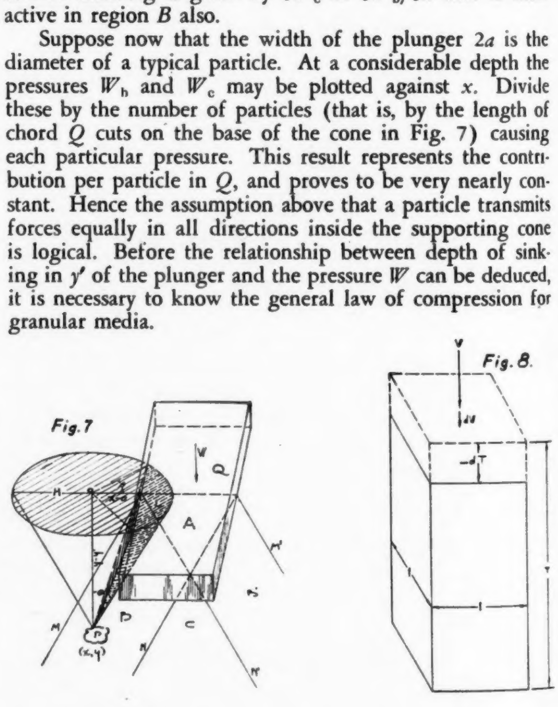


FIG. 7 (LEFT) RELATION OF P TO PARTICLES ABOVE IT IN RECEIPT OF FORCES. FIG. 8 (RIGHT) COMPRESSION IN RELATION TO DOWNWARD PRESSURE ON A COLUMN

Fig. 9.

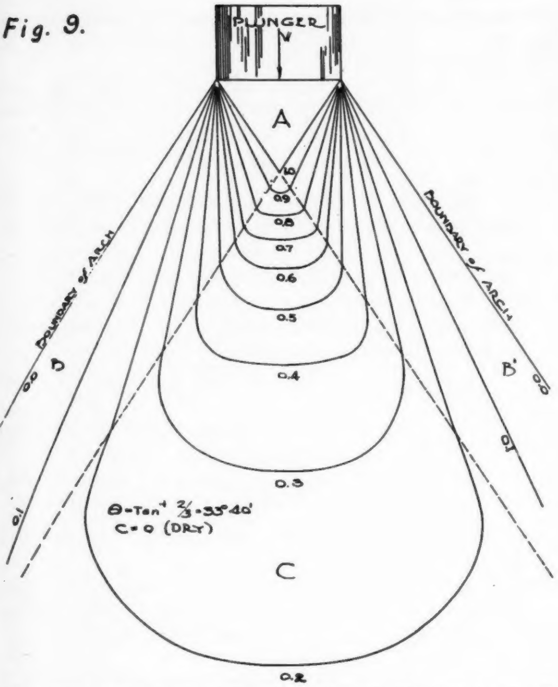


Fig. 11.

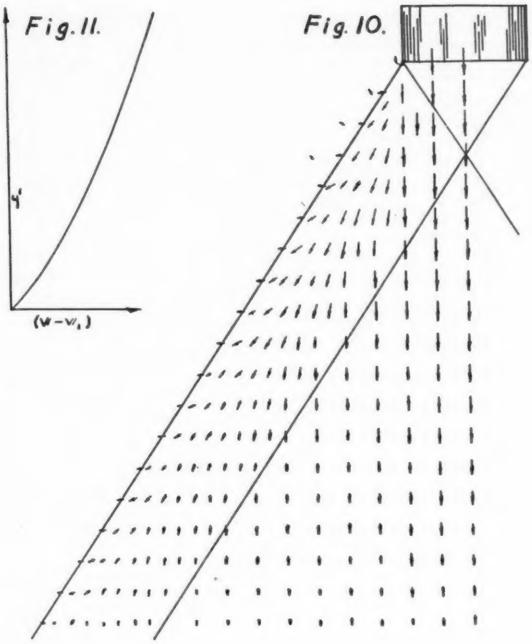


Fig. 10.

FIG. 9 (LEFT) ISOBARS OF DOWNWARD PRESSURE FOR THE RATIO (W_b OR c)/W. FIG. 10 (RIGHT) PREDICTED RESULTANT FORCE DIAGRAM IN THE ARCH UNDER A PLUNGER. FIG. 11 (CENTER ABOVE) THEORETICAL RELATIONSHIP BETWEEN SINKING AND LOAD ($W - W_1$), ASSUMING CONSTANT BEARING POWER INDEPENDENT OF DEPTH

THE LAW OF COMPRESSION

Consider a column of the medium of unit cross section and height T under a pressure W (see Fig. 8). An increase in pressure dW causes the thickness to change by $-dT$. The work done is $-W\,dT$, and is absorbed by the medium in the form of friction of particle on particle. The average force holding the particles in contact is $k_2W + C$. Let n be the number of particles per unit volume free to slip or readjust, and dt the average distance of slip required to reach a compaction that will support the added pressure dW. Then equating work put in to work absorbed,

$$-W\,dT = ns(k_1 W + C)\,dt. \qquad [20]$$

But n is the number of particles capable of finding a more compact arrangement, and is proportional to $(T - T_m)$, where T_m is the minimum thickness attainable without crushing. Also dt is proportional to dW. The cohesive force C depends on the number of contacts and is some function of W, say $k_1\, f\,(W)$. Hence equation [20] becomes

$$-W\,dT = K\,[W + f\,(W)]\,[T - T_m]\,dW. \qquad [21]$$

Separating the variables,

$$\frac{dT}{T - T_m} = -K\left\{1 + \frac{f\,(W)}{W}\right\}dW. \qquad [22]$$

Integrating,

$$\log_e\,(T - T_m) = -K\,[W + F\,(W)] + C_1, \qquad [23]$$

where

$F\,(W) = \int \frac{f\,(W)}{W}\,dW$, and C, the constant of integration

Letting $T = T_o$, when $W = O$, gives

$$\log_e[(T - T_m)/(T_o - T_m)] = -K[W + F\,(W)]. \qquad [24]$$

Changing to exponentials,

$$\frac{T - T_m}{T_o - T_m} = e^{-K\,[W+F\,(W)]}. \qquad [25]$$

For pressures up to 20 pounds per square inch a very close check of equation [25] with observed data results when the exponent $K\,[W+F\,(W)]$ is replaced by $K'W$, where K' is a function of moisture content. This indicates that the term $F\,(W)$ is proportional to W for that range of pressures.

Equation [25] states the law of compression, $(T_o - T_m)$ representing the total range of volume variation, from zero to large pressure. Since the bearing power of the medium may be W_1 instead of O, it is more convenient to use the corresponding T_1 than T_o in the above formula.
Now

$$T_1 = T_m + (T_o - T_m)\,e^{-K\,[W_1+F\,(W_1)]}. \qquad [26]$$

Eliminating T_o between [25] and [26],

$$T = T_m + (T_1 - T_m)\,e^{-K\,[W-W_1+F\,(W)-F(W_1)]} \qquad [27]$$

Here $(W - W_1)$ represents the excess pressure above the bearing power of the medium. The expression $(T_1 - T)$ represents the loss in volume caused by the excess pressure and is given by[3]

$$(T_1 + T) = (T_1 - T_m)\,\{1 - e^{-K\,[W-W_1+F\,(W)-F(W_1)]}\} \qquad [28]$$

[3]Since $T \times A$ (the area) $= V$ (the volume), multiplying both sides of equation [28] by a converts it into a pressure-volume relationship.

Fig. 9 shows the distribution of downward pressure for a case approximating dry soil with $s = 1$, $C = 0$, and $\tan\Theta = 2/3$. The isobars give the values of the ratio W_b (or W_c) to W. Suppose for example that $W = 2W_1$, then the isobar labeled 0.5 bounds that portion of the medium that has experienced downward compression. Outside of this region there is static support but the applied pressures are less than W_1, hence no downward motion has resulted. Fig. 10 shows the resultants (for a field) of downward and cross-pressures.

For any particular case such as that above it is possible to compute the change in density in the disturbed region by means of equations [28], [16], [17], and [18]. By use of the cross-pressure gradient the amount of material that has escaped around the edge of the plunger may be computed also. This loss in volume must equal the volume of the hole caused by the plunger. For a plunger of unit length this volume is $2\,a \times y'$. It is found that y' is very nearly proportional to the excess pressure $(W - W_1)$ when s, R and Θ have values appropriate to common soils. However, in such a case the density, and hence the bearing power, of the soil increases with depth due to the weight of soil above. Without this factor there would be a critical load at which sinking in would be indefinite, see Fig. 11.

If this relationship is written

$$c\,2a\,y' = W - W_1 \qquad [29]$$

then the work done by the plunger is

$$\text{work} = \int_0^{y'} (2acy' - W_1)\,dy' = acy'^2 - W_1 y' \qquad [30]$$

SUMMARY

The cohesive force (C) of moisture films and the coefficient of internal friction or shear (s) between average particles are chosen as the two fundamental properties upon which the theory of dynamics of granular media is based. The development is restricted to internal characteristics, and only such boundary phenomena as are independent of the properties of the bounding media.

In terms of (C) and (s) the following laws are derived:

1 The law of cross pressure stating the relationship between horizontal and vertical pressures.

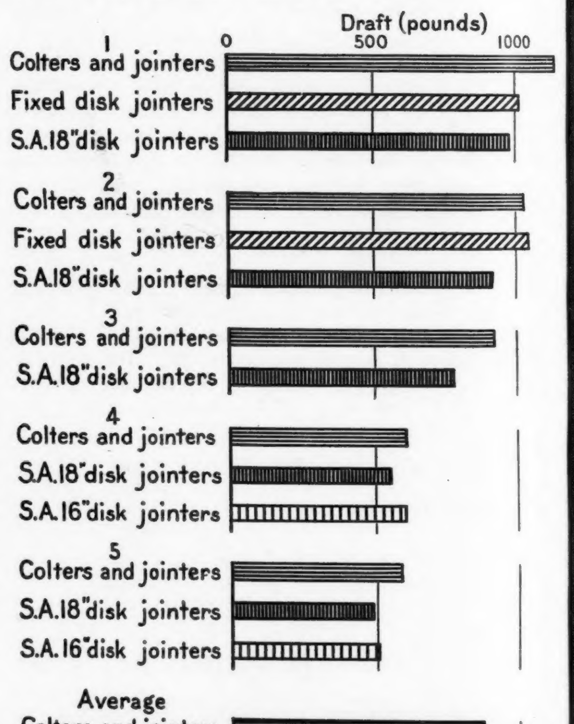
2 The law of arch-action, giving (a) the angle of arch, and (b) the distribution of pressures in the arch.

3 The general law of compression, giving the volume-pressure relationship.

4 The law of penetration, indicating a linear relationship between depth of sinking in and load on a plunger, for ordinary ranges and vertical path.

Self-Aligning Disk Jointer

FIELD STUDIES in the use and draft requirement of various plow attachments have definitely shown that the self aligning disk jointer described in a recent issue of AGRICULTURAL ENGINEERING, developed at Toledo by A. H. Glaves under the direction of R. M. Merrill (of the USDA Bureau of Agricultural Engineering) for better trash coverage in the corn borer control project, gives a definite reduction in plow draft. The accompanying chart summarizes the results of some draft tests made in 1935 with various plow attachments, and shows the average draft for the self-aligning disk jointers as 14.2 per cent less than for the colters and jointers. Test series 1, 2, and 3 were made in Ohio, series 4 and 5 in Illinois. As a further substantiation of the test results two 2-bottom 16-inch plows, equipped with self-aligning disk jointers, were loaned to farmers and were pulled by tractors which ordinarily pull two 14-inch bottoms. General-purpose 10-20 tractors pulled the plows quite successfully, on four rather widely separated farms in Ohio and Michigan this past season. One farmer said the 2-bottom 16-inch plow with the self-aligning disk jointers pulled even lighter than his own 2-bottom 14-inch plow with regular attachments. He has used the 16-inch plow for nearly 200 acres of plowing. The cut of the 16-inch plows is approximately 14.3 per cent wider than that of the 14-inch plows, which checks closely with the average results of the tests shown for the five series.



A contribution from the division of mechanical equipment, Bureau of Agricultural Engineering, U. S. Department of Agriculture.

AT RIGHT, RESULTS OF PLOW DRAFT TESTS SHOWING COMPARISON OF SELF-ALIGNING DISK JOINTER WITH COLTERS AND JOINTERS AND FIXED DISK JOINTERS

What Agricultural Engineers Are Doing

From the BAE, USDA

THE Bureau of Agricultural Engineering, U. S. Department of Agriculture, reports the following activities:

During April the CCC drainage camps of the Central District under the supervision of the Division of Drainage of the Bureau completed 5,235,315 square yards of clearing; 1,371,078 cubic yards of hand and machine excavation and embankment work, and 48,876 linear feet of tile reconditioning. This brought the accomplishment of the camps for the three principal classes of work being performed to a total of 67,000,000 square yards of clearing; 4,600,000 cubic yards of excavation and embankment, and 31 miles of tile reconditioning. Sixty draglines, including 12 government machines, were operated in the various camps during the month.

* * * *

Work on the Rio Grande joint investigation by the National Resources Committee, to which several members of the Division of Irrigation have been assigned, is progressing rapidly. A conference of Messrs. Harlowe Stafford, Fred C. Scobey, Paul A. Ewing, Harry F. Blaney, and Carl Rohwer was held in Santa Fe, New Mexico, April 5 to 8, for the purpose of formulating plans for carrying on the work assigned to the Division. Mr. Rohwer made a reconnaissance of the San Luis Valley. A site was chosen for installing a set of tanks on the Rio Grande to determine the evaporation and transpiration losses from tules, salt grass, and native hay. A similar installation is proposed for the hay meadows south of Monte Vista. Dean W. Bloodgood assisted in selecting locations for experimental work, at State College, New Mexico, making contracts with interested parties and locating data previously compiled that might be useful in connection with the investigations. Mr. Bloodgood also visited Albuquerque, Santa Fe, and El Paso for the purpose of consulting with those engaged or cooperating in the study.

* * * *

In order to bring together interested officials to discuss and judge data in connection with the snow cover measurement and irrigation water supply forecasting project, two meetings were held recently, one at Burley, Idaho, and one at Ontario, Oregon. The former meeting was attended by most of the state watermasters and irrigation project managers of Snake River Basin eastward from King Hill, also by the assistant state reclamation commissioner of Idaho. At the Ontario meeting, in addition to Messrs. Marr, Lewis, and Work of the Division of Irrigation, there were in attendance representatives of the USDI Bureau of Reclamation, the Eastern Oregon Power and Light Co., the Oregon state engineer's office, and state watermasters. Results of snow cover measurements of March 31 on the Colorado and Wyoming snow courses were compiled by Messrs. Parshall and Rohwer, and reports for each state prepared and distributed. The annual snow surveys over almost the entire Utah cooperative network were completed March 31, records were tabulated by George D. Clyde of the Utah Agricultural College, and a report prepared.

* * * *

In the cotton production machinery project, plots have been prepared near Prattville, Ala., to determine the most effective of several methods of turning under vetch. Moldboard, cylinder, and multiple-disk plows were used at several depths and speeds. Marked differences were noted in the completeness of coverage and the locations of the vetch in the turned soil. These plots will be bedded, planted, fertilized, and cultivated uniformly, and yield records will be obtained this fall. This study will give leads as to the most economical methods of turning this type of debris, both from the standpoint of the cost of doing the job and of the returns obtained. Due to the mounting importance of this problem, two manufacturers of farm machinery have had factory representatives observing these tests and the coverage problem in general. It has been stated by many farmers that they are planting all the winter legumes they can turn with their available equipment and would double their acreage if they were sure of being able to get the crop under.

* * * *

At this season an extensive series of observations are being made on the soil structure variations of the cotton production plots at Prattville, now in their fifth year of operation. About 500 samples were taken with the improved soil-sampling tube. These samples will furnish a definite basis of analysis of the soil structure induced by tillage operations. The plots are being sampled at two-inch horizons to a depth of 8 inches and in some instances to 12 inches. Marked variations have been noted in the various plots. High production plots have a combined fine and coarse aggregate to a depth of 7 or 8 inches. A plot having an open structure shows an appreciable amount of oxidation as compared with those having a more homogeneous structure.

* * * *

Field tests with the vapor method of spraying insecticides and fungicides are being made by O. K. Hedden of the Toledo office, in cooperation with the Ohio Experiment Station. This work is being carried on near Wooster, Barnesville, and Sandusky, Ohio.

* * * *

Tentative design of a hose coupling for use with single lengths of hose at high pressures has been made by E. M. Dieffenbach. Advantages claimed for the new coupling include strength, large passage for liquid, and low cost.

* * * *

A conference to complete plans for the procedure on the Bankhead-Jones grain storage was held in Chicago on May 4 and 5 in the federal grain supervision offices. Wallace Ashby, A. D. Edgar, C. F. Kelly, and Thayer Cleaver represented the Bureau of Agricultural Engineering. F. C. Fenton represented the Kansas Agricultural Experiment Station; E. W. Lehmann, Dr. H. C. M. Case, and Dr. O. T. Bonnett represented the Illinois Agricultural Experiment Station; and H. F. McColly represented the North Dakota Agricultural Experiment Station. R. T. Miles, W. B. Combs, F. C. Heiss, and others from the Chicago grain supervision office attended.

Contributions Invited

All public-service agencies (federal and state), dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

From Texas

THE division of agricultural engineering (H. P. Smith, chief), Texas Agricultural Experiment Station, College Station, reports the following projects recently started, which are of particular interest to agricultural engineers:

* * * *

"Study of Causes of Decay of Garlic and Methods of Control" (Project No. 376), in cooperation with the division of plant pathology and physiology. The objects of this project are twofold: (1) to determine the cause or causes of the decay which destroys the garlic crop before it leaves the field, or in transit to market; (2) to determine to what extent artificial drying will control or prevent decay. A dehydrator or dryer has been completed, and the first trial was made on May 26 and 27.

* * * *

"Atmospheric Exposure Tests of Wire and Fencing" (Project No. 377), in cooperation with the American Society for Testing Materials. This project is one of several being set up in the various regions of the United States by the ASTM. The objectives are: (1) to obtain useful engineering information concerning materials generally used for fencing or which offer promise of economic suitability for use in fencing in the near future; (2) to assist in setting up national standard specifications for fencing and barbed wire which will afford consumers in various climatic regions an adequate guide in purchasing these materials. The wire for this test will be set up within the next couple of months.

* * * *

"Study of the Control and Eradication of Prickly Pear" (Project No. 386), was begun about three years ago, but the project outline has only recently been approved. This project covers the study of chemical poisons and various control measures in connection with eradication of prickly pear (cactus) for Texas pasture lands. The manufacturers' relationship to this project would be in connection with the making of special spraying apparatus and chemical sprays to be sprayed on prickly pear.

NEWS

Observations on the 1936 Annual Meeting

THERE is a saying to the effect that anticipation is greater than realization, but in some respects at least the truth of this statement was not borne out in the 1936 annual meeting of the American Society of Agricultural Engineers held last month at the Stanley Hotel, Estes Park, Colorado. Advance registrations or other indications available to those in charge of meeting arrangements were not sufficient before hand to anticipate a record-breaking attendance; in fact, perhaps the most striking thing about the meeting was the unexpectedly large attendance. The largest meeting of record heretofore was the meeting at Ames, Iowa, in 1931, with a registered attendance of 450. However, the total registration of this year's meeting was 510 persons, including 303 men, 138 women, and 69 children. The number of women and children was practically double that of the Ames meeting.

In the registration, 38 states were represented. Illinois and Iowa tied for first place with 47 from each state, California was next with 42, and Nebraska was third with 39, followed by Colorado and Ohio with 36 and 35, respectively. Next came Kansas with 28, and then Texas and the District of Columbia with 24 each, followed by Missouri, Minnesota, and Georgia with 20, 19, and 17, respectively. On the basis of person-miles, Illinois was first, with Georgia or California second.

That many members combined attendance at the meeting with their yearly vacations is indicated by the unusually large number of women and children present. And, in the opinion of most of those who attended the meeting, it would be difficult to find a more suitable place for spending a vacation than in the vicinity of Estes Park. The unusually and unanticipated large registration would perhaps also indicate that there is a special preference among those who attend ASAE meetings for the type of meeting place which Estes Park provided. A number have already commented to this effect, and it will be interesting to get the views of others for guidance in the selection of meeting places in the future.

The registered attendance also included between 35 and 40 students in agricultural engineering from eight or ten different state colleges and universities, a total of which, not counting students of local institutions at previous meetings, is in excess of student registration at any previous meeting. At this meeting the National Council of Student Branches was formally organized under a set-up approved by the Council of the Society. One of the outstanding features of the entire meeting program was the student sessions.

Under the able direction of Mr. and Mrs. E. M. Mervine, together with the assistance of a number of members and other local agencies—and of course including the very efficient organization at the Stanley Hotel—the comfort, convenience, and pleasure of those attending the meeting was amply provided for. Parents especially expressed enthusiastic appreciation of the excellent provisions made for caring for and entertaining the children.

Beautifully situated in the foothills of the Rockies, and in full view of a number of well-known peaks, the setting of the Stanley Hotel was something beyond the power of this writer to describe, but certainly a superb place to hold an annual meeting of ASAE—to be followed by an aftermath, for those who desired, of mountain climbing, fishing, and vacationing generally. It was a meeting which ASAE members and their families will be talking about for years.

In order to permit more time for individual contacts, group conferences, sightseeing, etc., a new arrangement in regard to scheduling of meeting sessions was tried out at the meeting this year, namely, to start the day with a two-hour general session, followed immediately by parallel sessions of two hours each of the technical divisions, the aim being to complete the formal program for each day before luncheon, leaving the afternoon free for those in attendance to do as they wished. This writer heard no objections to this arrangement, but rather a number of enthusiastic comments in favor of it. It would seem that such an arrangement is particularly desirable in the case of a meeting situated as the one this year was.

The meeting went off pretty much according to schedule, the College Division and the student group starting off with two parallel sessions the first thing Monday morning, and joined by the extension group during the middle of the morning. A feature of the afternoon was an open meeting of the Committee on Federal Activities Related to Agricultural Engineering. The evening was devoted to an illustrated talk on the recent findings in regard to prehistoric man in Colorado.

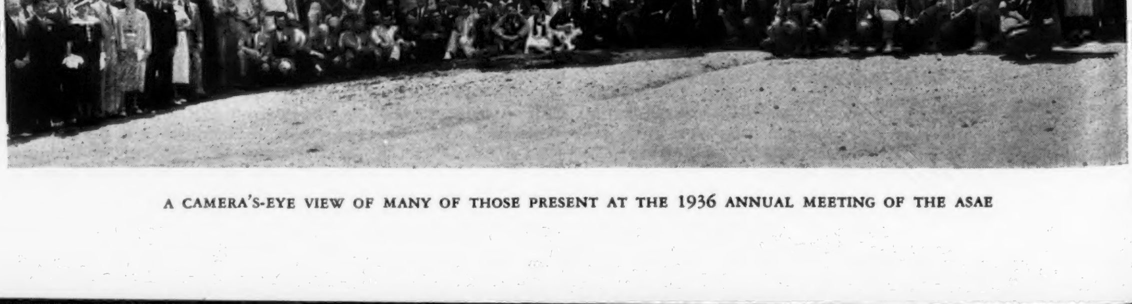
The annual meeting was formally opened Tuesday morning, June 23, with the address of the President of the Society, L. F. Livingston, followed by a paper on the necessity and economic use of water in agriculture by Dr. Charles A. Lory, president of the Colorado State College. This general session was immediately followed by two joint sessions, in one case the Power and Machinery and Soil and Water Conservation Divisions, and in the other, the Farm Structures and Rural Electric Divisions. In the afternoon. most of those in attendance engaged in a trip to the top of the mountains which they will not soon forget.

The evening program featured illustrated talks on electrical horticulture and wild life in the Rocky Mountain National Park.

The Wednesday program was opened with another general session featuring an address by H. B. Walker, professor of agricultural engineering, University of California, on looking ahead in agricultural engineering, which was followed immediately by concurrent sessions of the four technical divisions.

Interspersed with a steak fry in the middle of the day a short distance from the Stanley Hotel, the day's program was concluded with the annual business meeting in the afternoon and the annual dinner in the evening, the attendance at the latter being 389 persons.

Ivan D. Wood, extension agricultural engineer of Nebraska, presided as toastmaster at the dinner, in his *(Continued on page 308)*



A CAMERA'S-EYE VIEW OF MANY OF THOSE PRESENT AT THE 1936 ANNUAL MEETING OF THE ASAE

Washington News-Letter

from AMERICAN ENGINEERING COUNCIL

THERE are at present in Washington two movements which tend, in part, to offset each other, but about which very considerable will no doubt be heard during the next few months. On the one hand, are groups of men within and without the government working on new plans for federal bureaus or departments which will take over the work of the Emergency Agencies which have, for one reason or the other, been dropped. For example, a number of plans are under way for the revival of the NRA on some new legal base. Some of the new plans take the form of setting up an over-all agency similar to the old NRA, and others take the form of special legislation such as the Ellenbogen Bill for the control of the textile industry, which in essence is a "little NRA"; the Guffey Bill for the control of the coal industry is similar in purpose. Recent decisions of the Supreme Court have made the legal basis for these various new plans problematical, nevertheless plans are under discussion to introduce in the next Congress forms of legislation which will meet the constitutional requirements.

Hand in hand with these activities which, if carried out, will further increase the number and complexity of the government operations, three committees have been appointed to consider the possibility of consolidation and simplification of government organization; one by the Senate, one by the House, and a third by the President.

The staff of American Engineering Council has been requested by the President's committee to confer with its staff and make suggestions and the Brookings Institution has been provided with recommendations of earlier committees of Council with reference particularly to public works administration, mapping and water resources.

* * * *

The consequences of the Bound Brook Decision by the Court of Appeals of the District of Columbia, declaring the use of the relief funds for the construction of a suburban community unconstitutional, arouses an uncertainty about the use of relief appropriations for any but relief purposes. Some believe it carries the implication that the Emergency Relief Acts could be declared unconstitutional if the Supreme Court should decide that Congress exceeded the authority vested in it by the people to delegate power to the Chief Executive. Should other invalidating decisions follow this one, almost every emergency agency and some of the activities of permanent government organization might be reduced to simple programs for more direct assistance to relief families. In the minimum wage decision, five members of the Supreme Court refused to amend the constitution by taking away from the people rights which the people had reserved for themselves. One justice thought the minimum wage law might possibly be upheld on the ground that women are entitled to special protection and three others insisted that state governments do not have the power to fix wages. The ramifications and social implications of the case open up another vital question in a number of other states involving many confusions of purposes.

* * * *

The Bureau of Public Roads has completed a study of operating costs on vehicles in comparison with highway expenditures on all classes of roads in a number of northern states. They report operating costs per mile varying from 0.5 to 1.08 cents on city streets and from 0.83 to 3.1 cents on county roads and state systems. In some instances the actual savings accruing to operators of vehicles from the conversion of dirt roads to hard surface highways has been as much as 3 cents per mile. On the basis of these findings, says the Bureau, the improved mileage of highways of the country are showing tremendous profits on the people's investment in them. A check on these observations is found in actual payment of gasoline taxes and motor vehicle fees.

In the recent transportation conference of the U. S. Chamber of Commerce, Thomas H. McDonald, chief of the Bureau of Public Roads of the Department of Agriculture, offered the following timely observations: "Almost without exception it is the old-time structures that are most seriously damaged by floods and therefore replacement costs are partially chargeable to obsolescence. The severe winter caused more actual loss in the form of deterioration to low cost road surfaces than flood damage. Large increases in mileage of low cost public highways is certain to rapidly increase maintenance costs to a point where they may take the place of necessary new construction of the better class. Such a policy, although commendable within reasonable limitations, tends to destroy logical and necessary step by step construction of permanent highway systems in states adopting it."

* * * *

Emergency construction program of the treasury department under the $65,000,000 Act of June 19, 1934, has a total of 361 projects with allotments amounting to $65,990,044. Ninety-two of them are complete and one hundred ninety-four are under construction. Allotments for 367 projects totaling $59,603,879 have been made against the $60,000,000 program provided for in the Act of August 12, 1935. Sixty-two of them are under construction. Definite commitments have been made for sites, plans and specifications for all other projects in these programs. Exact figures are not available but it appears that less than 5 per cent of this work has gone to engineers and architects in private practice.

* * * *

Public Works Administrations activities, involving commitments of billions in grants and loans, have only obligated that administration to accept $828,047,864 in bonds from states, counties, municipalities, and other borrowing bodies. That fact indicates that large purchases of such bonds must be made as construction progresses. Of the $543,764,734 actually purchased to date, $406,843,571 have been sold to the Reconstruction Finance Corporation. Since the funds realized from the sale of such bonds by the Public Works Administration may be used to buy more bonds from borrowing bodies, it is evident that any substantial appropriation for "grants" by this Congress will assure the continuation of a very substantial PWA Program.

According to the F. W. Dodge Corporation, publicly financed construction work of the class benefited by the Public Works Administration has doubled its volume of a year ago—a new high since the depression. The total for April, both public and private, in 37 eastern states was $780,627,600, of which public projects accounted for 54 per cent of the total value. That means that private construction has reached the highest figures in five years, but it is still only a fraction of its normal volume.

The power division of the Public Works Administration reports 112 of 132 communities in 32 states have recently voted to assess themselves for publicly owned utilities. It is interesting to note that 28 of these communities have less than 1000 population, 28 have less than 2000, 35 have less than 5,000, 21 have less than 10,000 and only 56 per cent of those above 10,000 voted for publicly owned utilities. Seventy-four of the older public utility projects are complete and one hundred and eight are under construction. Sixty-two projects in 26 states are delayed by litigation. Of them 39 are under restraint in the Federal Court of the District of Columbia.

* * * *

Rural Electrification Administration now has a permanent status. Its reports accelerated expansion of loans to both private utilities and cooperatives, but the total loans in the first year for the entire 76 projects involving approximately 12,000 miles of line to serve about 40,000 customers in 25 states was only $12,331,412. That is a good start but it indicates that citizens in rural areas are slow to obligate themselves, even through cooperatives, to liquidate relatively large loans for power lines and hesitate to commit themselves to the direct purchase and installation of electrification for their individual homes.

Since REA funds are only advanced to sponsors as economic, legal, and engineering requirements are satisfied, it must be admitted that the services of practical engineers are essential to the success of the program. Speaking about the situation, Administrator Morris L. Cooke says, "it requires a new type of engineer—a rural engineer—who is intimately acquainted with the practical problems that the farmer has to face and can make practical suggestions which will stand the test of experience."

It is our observation that many engineers who have already been tested by rough experience are available. They may develop opportunities in the promotion, design, construction and operation of rural electrification systems and in the sale and installation of farm equipment and home appliances. Some may find it profitable to go into the several phases of the rural electrification business and others may secure employment with private and public utilities, contractors and supply houses who go after that business.

* * * *

Social security faces the enormous task of getting employer cooperation in recording pertinent data on 26,000,000 persons for the old age benefits program. Employers are asked for earnings and personal data will be gotten from employees. Set-up will include 12 regional and approximately 100 district offices with personnel under civil service.

* * * *

At the suggestions of some of the secretaries of member organizations, observations indicating trends in the employment of engineers are being included in this news-letter for the information of members of all member organizations.

All engineers seeking employment should know that there is an excess of engineers, as well as other employees at this time, in government service. Many are kept on government payrolls as long as funds are available to provide them with a subsistence until they can find an opportunity to make a living somewhere else. It is not the case

in the permanent agencies, and it is not so true in regional, state, and local offices, but much of it is being done in the emergency agencies.

A very few vacancies are available at almost all times, but there is keen competition among engineers in the service as well, as from the outside for them. Those on the inside have the advantage of experience and the influence of personal acquaintances, even though they may not be as well qualified for the positions.

The most promising prospect, at this time, for the expansion of engineering employment in government service is with the Rural Electrification Administration. Most of the opportunities will be with the borrowing bodies in those states participating in the programs and with contractors and supply houses who go after rural electrification business.

It is obvious, however, that many engineers in government service will soon have to find work in private employment and practice, and it is evident that those who are first to make the change are likely to get the better opportunities. On that premise, it is suggested that engineers rise above the current storm of political confusion and observe that their training and experience is admittedly essential in the modernization of business and industry to bring about the necessary economic balance between production, distribution, and consumption.

Observations on the 1936 Annual Meeting

(Continued from page 306)

usual pleasing and efficient manner. The high spot of the occasion was an interesting and instructive address by Philip Sheridan Rose, editor of "Country Gentleman," and a charter member and the third president of the Society. This address was followed by the award of the Farm Equipment Institute cup to the student branch of the Society of Iowa State College, and the award of the Cyrus Hall McCormick Medal posthumously to the late Dr. Elwood Mead, the former Commissioner of Reclamation and a charter member of ASAE. The medal was received by Mrs. Mead, and a most fitting and beautiful tribute was paid Dr. Mead and his great achievements in the field of reclamation engineering by Miss Mae A. Schnurr, assistant to the commissioner of reclamation, U. S. Department of the Interior, a position which she held for twelve years as the close and able associate of Dr. Mead.

As a conclusion to the annual dinner program, the retiring president, L. F. Livingston, manager, agricultural extension section, E. I. du Pont de Nemours & Company, formally installed his successor, R. U. Blasingame, head, agricultural engineering department, the Pennsylvania State College, as president of the Society for the year 1936-37.

No general sessions were held on Thursday, the last day of the meeting, and the four technical divisions wound up their programs with three-hour sessions ending at 12 o'clock noon.

The Council of the Society in one of its sessions held during the meeting voted to hold the 1937 annual meeting at the University of Illinois in the twin cities of Urbana-Champaign. E. W. Lehmann, head of the agricultural engineering department of that institution, will serve as chairman of the local committee for the meeting, and Frank P. Hanson, Caterpillar Tractor Company, Peoria, was again selected as chairman of the Meetings Committee.

It will be remembered that at the annual meeting at Athens, Georgia, in 1935, the members present at the annual business meeting went on record in favor of holding the 1938 meeting in California. Santa Cruz has been selected as the meeting place, and already preparations for the 1938 meeting are well under way.—RO

Cyrus H. McCormick Passes Away

CYRUS H. McCORMICK, one of the donors of the ASAE's Cyrus Hall McCormick Medal, passed away June 2, following a heart attack on May 30.

Born in 1859, educated in Chicago public schools and Princeton University, Mr. McCormick entered the McCormick Harvesting Machine Company founded and headed by his father, became its president in 1884, and first president of the International Harvester Company which he was instrumental in organizing in 1902. He continued to head the organization first as president, and later as chairman of the board of directors, until 1935, when he retired as chairman but continued as a member of the board until his death.

Mr. McCormick was active in other business organizations, recipient of many honors, and a philanthropist whose generous gifts of time and money covered a wide range of benefactions.

In 1931 he, together with his sister, Mrs. Emmons Blaine, and his brother, Harold F. McCormick, made a gift to the American Society of Agricultural Engineers which made possible the annual award of a Cyrus Hall McCormick Medal, in honor of their father, the inventor of the reaper, "for exceptional and meritorious engineering achievement in agriculture."

Necrology

RAY B. WEST, dean of the School of Engineering, Utah State Agricultural College, passed away June 3, 1936. He was a native of Utah and his career closely identified with the Utah State Agricultural College. After receiving a bachelor's degree there in 1904 he studied at Cornell University and there received the degree of Civil Engineer in 1906. After six years of private practice he returned to Utah State Agricultural College as professor of agricultural engineering and director of the School of Agricultural Engineering and Mechanic Arts. For the past twenty years he has been a member of the ASAE and active in its Soil and Water Conservation Division. He is survived by his widow, Mrs. Mary M. West.

Personals of ASAE Members

Thayer Cleaver and *R. I. Shawl* are joint authors of University of Illinois Circular 450, entitled "Better Plowing." This circular represents cooperative work between the USDA Bureau of Agricultural Engineering and the department of agricultural engineering, University of Illinois.

M. M. Johns has left the service of Virginia Polytechnic Institute to accept a position as extension agricultural engineer in rural electrification in the agricultural extension service of the University of Tennessee at Knoxville. He started work in his new position June 1.

John E. Nicholas, associate professor of agricultural engineering, Pennsylvania State College, presented a paper, entitled "The Farmer's Egg Precooling Problem," at the summer meeting of the American Society of Refrigerating Engineers which met at Skytop, Pennsylvania, last month.

R. H. Wileman is author of Circular No. 217 of the Purdue University Agricultural Experiment Station, on "The Purdue Plow Trash Shield."

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

E. S. Abele, engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 754 Amelia St., Zanesville, Ohio.

Weldon F. Appelt, student training division, Allis-Chalmers Manufacturing Co. (Mail) Hallettsville, Tex.

John B. Burgess, salesman, International Harvester Co. (Mail) Ettrick, Va.

Fred C. Chambers, Minatare, Nebr.

Lee M. Cleland, superintendent, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp SCS-20-Ohio, New Lexington, Ohio.

C. Carl Cunningham, project superintendent, Soil Conservation Service, U. S. Department of Agriculture. (Mail) ECW Camp SCS-7, Burlington, Kans.

N. DeWind, president and general manager, The Parsons Co., Newton, Iowa.

M. M. Finke, Allis-Chalmers Mfg. Co. (Mail) 629 15th Ave. S.E., Minneapolis, Minn.

William S. Greer, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Gambier, Ohio.

Kay Halsell, II, 3405 College Ave., Bryan, Tex.

H. G. Knoderer, commercial engineer, General Electric Co., Bridgeport, Conn.

Joe F. Krizek, Box 383, Port Lavaca, Tex.

D. B. Lancaster, Oenaville, Tex.

W. E. Moore, Jr., 315 N. 7th St., Temple, Tex.

J. Y. Orms, 3005 Ennis Ave., Bryan, Tex.

Charles B. Parrett, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 116 E. Bowman St., Wooster, Ohio.

C. G. Rhode, Charlotte, Tex.

Marvin J. Samuelson, Minneapolis-Moline Power Implement Co. (Mail) Oakland, Nebr.

R. J. Schwendeman, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 116 E. Bowman St., Wooster, Ohio.

Harold E. Stover, extension engineer, Kansas State College, Manhattan, Kans. (Mail) 1622 Leavenworth St.

A. F. Wilt, agricultural engineer, Ethyl Gasoline Corporation, Detroit, Mich.

John W. Young, Kyle, Tex.

TRANSFER OF GRADE

C. G. Krieger, agricultural engineer, Ethyl Gasoline Corporation, Detroit, Mich. (Associate Member to Member)

Agricultural Engineering Digest

A review of current literature by R. W. Trullinger, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

Rainfall Intensity-Frequency Data, *D. L. Yarnell.* U. S. Dept. Agr., Misc. Pub. 204 (1935), pp. 68, figs. 76. This is a compilation of data relating to rainfall intensity and frequency covering periods of from 10 to 50 years as recorded at the 206 Weather Bureau rainfall stations equipped with automatic rain gauges. "It is believed that this study has developed data sufficient for predicting with reasonable accuracy the period of recurrence of intense precipitations in any part of the United States." The data also furnish a basis for computing required capacities for drainage systems, storm sewers, culverts, etc., to safely care for excessive precipitation.

Apple Storage, *G. F. Potter.* Amer. Fruit Grower, 55 (1935), no. 9, pp. 5, 6, 12, 14, figs. 3. In this general discussion the author points out that at the New Hampshire Experiment Station findings have shown that whereas 30 degrees Fahrenheit lengthened the keeping life of McIntosh apples, the ultimate quality was not equal to that of fruit held at 32 degrees. In from 30 to 35 days a temperature of 32 degrees killed all railroad worms in apples. The holding of McIntosh apples for from 4 to 5 days at ordinary outdoor temperatures prevailing at harvest markedly reduced internal break-down in stored fruit. Scab lesions increased in size in storage at 32 degrees, indicating the need of careful spraying and selection of fruits. Picking maturity was highly important; for example, Cortland when picked early scalded badly even if wrapped in oiled paper, and if picked late was especially susceptible to break-down in the outer cortical area. Fertilizer treatment had no material effect on keeping quality of apples.

The Internal Atmosphere of Apples in Gas-Storage, *F. Kidd* and *C. West.* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 110, 111. In a population of Bramley Seedling apples stored in air at 15 degrees Centigrade, (59 degrees Fahrenheit) it was found that the difference in concentration of oxygen and carbon dioxide between the internal and external atmospheres gave, when plotted against the time, a curve similar to that for respiratory activity. The actual differences varied between 2 and 5 per cent. In Sturmer Pippin apples the differences were as great as 8 to 9 per cent.

The Cause and Control of Low-Temperature Break-down in Apples, *F. Kidd* and *C. West.* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 117-119, figs. 2. Apples of high nitrogen type, presumably susceptible to breakdown, gathered at three different stages of maturity, namely, preclimacteric, climacteric, and postclimacteric and stored at 34 degrees Fahrenheit, attained 25 per cent breakdown in 172, 103, and 120 days, respectively. Since respiratory activity was slightly higher in the early gathered fruits, the author suggests that there is some other factor involved in breakdown than simply the pitch of respiratory activity.

Injury in Australian Apples Due to Carbon Dioxide at Low Temperatures, *J. Barker* and *F. Kidd.* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 109, 110. Observations on Sturmer Pippin and King David apples held at temperatures of 25, 28, 32, and 41 degrees Fahrenheit in two atmospheres containing (1) 2 per cent carbon dioxide and 19 per cent oxygen, and (2) 5 per cent carbon dioxide and 16 per cent oxygen showed that both varieties are susceptible to low temperature breakdown at 32 degrees, that the presence of 5 per cent carbon dioxide may cause brown heart at temperatures below the optimum, and that 5 per cent carbon dioxide may be markedly beneficial at a temperature of 41 degrees.

Effect of Different Temperatures, Humidities, and Free Ammonia on Pecans in Storage, *O. C. Medlock.* Natl. Pecan Assoc. Proc., 32 (1933), pp. 21-28; abs. in Alabama Sta. Rpt. 1934, p. 7. Four years' storage studies with Frotscher and Stuart pecans indicated that temperature is the outstanding factor concerned in successful storage. Nuts of both varieties kept in good marketable condition for one year or longer at 32 degrees Fahrenheit in either low or uncontrolled relative humidity. Under high temperatures kernels of the Frotscher molded more than did those of Stuart, but the latter became rancid somewhat earlier. At all three temperatures, namely, 32, 40, and 50 degrees, uncured nuts kept as well as cured nuts; in fact mold did not develop as readily on the kernels of uncured as on cured nuts. Although 40 degrees was more effective than 50 degrees, it was not low enough to hold nuts in good condition for a year. The presence of free ammonia in the storage chamber caused darkening of the surface of the kernels.

Combustible Gaseous Products of Fruits, *R. Gane* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 124-128, figs. 2. Measurements of the total amount of combustible gaseous substance produced by ventilated ripe oranges held at 15 degrees Centigrade (59 degrees Fahrenheit) showed a constant output as long as the fruits were sound, after which the output of combustible gases and of carbon dioxide greatly increased. In another test, doubling the rate of ventilation after eight days approximately doubled the output of combustible matter, and the removal of the outer layers of the peel greatly increased the production of combustible material and of carbon dioxide. In experiments with bananas ripening at 15 degrees (C) there was noted a large and rapid increase in the output of combustible substances in the later stages of maturity. The injury of green bananas did not stimulate their rate of ripening. The ozone and iodine pentoxide methods of estimating unsaturated gaseous products are discussed.

The Effect of Ethylene on Apples at Low Temperatures: Evidence for the Production of Ethylene by Unripe, Immature Fruit, *F. Kidd* and *C. West.* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 119-122, figs. 2. No effect was produced on the production of carbon dioxide when Bramley Seedling applies already showing a steady slow rise in respiratory activity in storage at 1 degree Centigrade (33.8 degrees Fahrenheit) were treated with ethylene. The same result was secured when Sturmer Pippin apples gathered in the preclimacteric state and stored immediately in individual ventilated glass containers at 3 degrees (C) were treated with ethylene. It was evident that ethylene is without effect during the slow progress of the climacteric rise in fruits held at low temperatures. Immature Bramley Seedling apples averaging only 29 grams in weight and stored at 10 degrees (C) in airtight but ventilated receptacles showed a rise in respiratory activity from ethylene applied prior to but not subsequent to their normal climacteric, indicating that ethylene is produced by immature apples and that there must be a threshhold value for the stimulating dose below which no effect is produced.

Removal of Spray Residues from Apples, *D. E. H. Freier* and *H. N. Worthley.* Pennsylvania Sta. Bul. 318 (1935), pp. 13, figs. 3. Stating that spray residues exceeded the legal tolerance in many instances in 1934 in Pennsylvania, the authors report the results of analyses of about 500 samples of apples subjected to different cleansing treatments.

Dry brushing was not found satisfactory, and in fact certain lots had more residue after brushing than before. Hand dipping gave fair results but is conceded to be practicable only in the case of small quantities. Flotation washers gave good results even with cold acid washes when the residues were not too great or complicated by heavy applications of oil. Washers provided with brushes were the most effective of all types tested.

Tests of alkaline and acid wash solutions indicated that under Pennsylvania conditions dilute solutions of hydrochloric acid are most effective. Concentrations above 2 per cent by weight of hydrochloric acid tended to injure fruit; 1.5 per cent was considered most satisfactory. Heating the washing solution to 100 degrees Fahrenheit increased greatly its cleansing capacity and is recommended for fruits difficult to cleanse. The addition of common salt interfered with the removal of lead residues. Varieties differed markedly in their ease of washing, the Stayman Winesap and Smokehouse cleansing most readily, with Hubbardston the most difficult variety. When the fruit was properly rinsed, washing with dilute hydrocloric acid apparently did not impair keeping qualities.

The technic of preparing washing solutions is discussed, and a brief description by A. W. Clyde is included of a small home-made flotation washer. *(Continued on page 312)*

Agricultural Engineering Digest

(Continued from page 309)

THE METABOLISM OF NITROGEN BY APPLE FRUITS DURING DEVELOPMENT ON THE TREE AND IN STORAGE, *A. C. Hulme.* [Gt. Brit.] Dept. Sci. and Indus. Res., Food Invest. Bd. Rpt., 1934, pp. 135-143, figs. 7. Seeking to establish whether changes in nitrogenous fractions of the apple could be related to break-down, observations were made on Worcester Pearmain and Bramley Seedling fruits, nonsusceptible and susceptible varieties, respectively, stored at 1 and 4 degrees Centigrade in air and in various mixtures of carbon dioxide, oxygen, and nitrogen. The data are said to suggest that there may be some connection between low temperature break-down and abnormalities within the soluble nitrogen fraction. About 50 to 55 days before break-down the amino acid nitrogen rose to a maximal percentage of the soluble nitrogen in one degree Bramley Seedling apples, whereas in Worcester Pearmain apples there was only a barely significant rise at 173 days. The decline in soluble nitrogen continued through the life of the Bramley Seedling apple. Apples from ringed trees appeared to contain more of their soluble nitrogen in amino acid form than did those from unringed trees. Observations on apples gathered at different stages of development showed a striking decrease in the total soluble nitrogen as a percentage of total nitrogen in both peel and pulp in the early stages. There was no great change in total protein and total soluble nitrogen fractions during the climacteric rise in respiration. An increase in protein during storage at the expense of soluble nitrogen was again apparent.

HARVESTING AND STORAGE OF MCINTOSH AND FAMEUSE APPLES, *M. B. Davis* and *D. S. Blair.* Canad. Hort. and Home Mag., 58 (1935), No. 9, pp. 205, 206, figs. 2. Studies at the Central Experimental Farm, Ottawa, indicated that McIntosh and Fameuse apples keep best when harvested at the time the flesh gives refractometer readings of 13 and 12 to 12.5 per cent, respectively. The iodine-starch test was also useful in establishing proper picking dates, and certain physical factors, such as seed color, fruit color and size, and ease of separation from the spur are described as useful indexes to maturity. The holding of Fameuse apples more than 48 hours after picking and before storage resulted in a marked increase in internal break-down. In the case of immature apples, storage at 30 and 32 degrees Fahrenheit increased the amount of scald as compared with 36 or 40 degrees, but fruit picked at the proper stage did not show these differences. Although 40 degrees was a safe temperature for McIntosh, it was apparently too high to prevent ripening in storage. McIntosh apples held in a 7.5 per cent carbon dioxide atmosphere at 38 or 40 degrees kept better than fruits in normal air.

INFLUENCE OF STORAGE TEMPERATURE AND HUMIDITY ON KEEPING QUALITIES OF ONIONS AND ONION SETS, *R. C. Wright, J. I. Lauritzen,* and *T. M. Whiteman.* U. S. Dept. Agr., Tech. Bul. 475 (1935), pp. 38, figs. 12. Observations on several varieties of onions, purchased for the most part on the open market and stored under controlled conditions at Arlington Experiment Farm, Va., showed that the amount of sprouting occurring during storage is influenced but little by humidity but rather definitely by temperature. On the other hand root formation was little influenced by temperature, but it was increased by increasing the humidity. The amount of decay showed only a slight general tendency to increase as both temperature and relative humidity were increased, and most of the decay was identified as neck rot. Onion sets showed an increase in sprouting, rooting, and decay as the storage temperatures increased and as relative humidities increased at each storage temperature. The best storage environment for both onions and sets was found to be 32 degrees Fahrenheit with a relative humidity of about 64 per cent. Physiological break-down, comparable in symptoms to the results of freezing injury, was observed in both storage and field before any actual freezing occurred. In Yellow Globe onions stored at 32 degrees there was noted a somewhat higher percentage of affected bulbs in lots in the higher humidity chambers. In the experiments break-down was manifested by a very limited amount of watery discoloration in the outer scales only.

NEBRASKA TRACTOR TESTS, 1920-1935. Nebraska Sta. Bul. 296 (1936), pp. 31, fig. 1. This bulletin summarizes the results of eighty tractor tests and includes data on all tractors reported on the market on January 1, 1936.

TRANSIT-REFRIGERATION CHARGES ON FRUIT REDUCED BY RECENT DISCOVERIES, *D. F. Fisher* and *C. W. Mann.* U. S. Dept. Agr. Yearbook 1935, pp. 317-319. In discussing the importance of refrigeration in the transportation of the vast Pacific coast fruit crop to eastern markets, the authors report that recent studies have shown that instead of reicing every 24 hours during the journey one reicing suffices if the fruit is cold at the start. Precooling of pears permitted the loading of more boxes per car, with consequent transportation savings.

ROOF COVERINGS FOR FARM BUILDINGS AND THEIR REPAIR, *A. D. Edgar* and *T. A. H. Miller.* U. S. Dept. Agr., Farmers' Bul. 1751 (1935), pp. II + 30, figs. 26. This bulletin describes the common types of roof coverings classified as rigid shingles, bituminous roofing, metal roofing and canvas roofing, and details the essential steps to be taken in making repairs. Information regarding certain roofing details is also given, including such items as nails, flashing, gutters, downspouts, and snow guards.

OXIDATION AND GAS FORMATION IN THE SPONTANEOUS HEATING OF HAY, *E. J. Hoffman.* Jour. Agr. Res. [U. S.], 51 (1935), no. 6, pp. 527-546, figs. 3. In a series of large-scale experiments on the spontaneous heating of alfalfa hay, conducted by the USDA Bureau of Chemistry and Soils, hay was stored under varying conditions in order to determine those conducive to excessive heating and ultimately to spontaneous ignition, as well as to investigate the causes and effects of spontaneous heating under these conditions. The results of analyses of the gases formed during the heating of hay in these experiments showed a striking similarity to the results of a laboratory study designed to determine the relative tendency of undecomposed and decomposed hay to absorb oxygen. For this reason both investigations are presented in this paper.

The results indicate that along with the operation of biological agencies in the heating haymow there occurs a purely chemical oxidation, evidenced by a loss of oxygen considerably in excess of the carbon dioxide formed. This chemical oxidation is more marked beyond the temperature range usually ascribed to the activity of micro-organisms.

FLOODS IN THE UNITED STATES: MAGNITUDE AND FREQUENCY, *C. S. Jarvis et al.* U. S. Geol. Survey, Water-Supply Paper 771 (1936), pp. 497, pls. 3, figs. 22. This report, prepared in collaboration with the Water Planning Committee of the National Resources Board and its predecessors the Mississippi Valley Committee, presents much of the basic information on floods now available for certain rivers in the United States. For some rivers the characteristics relating to stages and flows of floods are compiled and analyzed for the first time. The objective has been to review the technic and procedure of estimating expected floods and to compile, in a form suited for ready reference, flood statistics for streams where long-time records are available. The results of the study here presented are a substantial contribution to this end.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE CORNELL STATION [New York] Cornell Sta. Rpt. 1935, pp. 65, 66, 72. The progress results are briefly presented of investigations on milk-cooling equipment by H. W. Riley, B. A. Jennings, et al, milk-house construction and equipment by Jennings, Riley, M. W. Nixon, H. J. Brueckner, et al, electric brooding of chicks by F. L. Fairbanks and J. H. Bruckner, and soil erosion control by A. F. Gustafson.

NATIVE MATERIALS FOR FARM INSULATION, *C. H. Jefferson* and *C. S. Bryan.* Michigan Sta. Quart. Bul., 18 (1935), no. 2, pp. 75-81, figs. 6. Laboratory and field experiments to determine the practicability of sawdust, shavings, and other native materials for insulating farm buildings are briefly reported.

The results show that several readily available native materials, such as sawdust, shavings, peat moss, and ground corncobs, have high insulating value if they can be kept dry. There seems to be no serious objections to using these materails for insulating purposes if some precaution is taken to reduce passage of moisture through the walls, or if the materials are treated with some preservative. Coarse shavings are more desirable than sawdust because they are usually more resistant to decay and do not settle readily. Ordinary hydrated lime dry-mixed with the insulation material seems the most practical preservative to use. It is easy to handle, retards microbial growth, and keeps out rodents. About 2 pounds of lime to every 100 pounds of shavings or about 0.25 pound of lime to a bushel of shavings is a suggested proportion. These native materials are not suggested as a substitute for commercial insulation in all cases, but where they are available they are said to offer an economical solution to the problem of insulating all types of farm buildings.

DUST EXPLOSION AND FARM FIRE INVESTIGATIONS. U. S. Dept. Agr., Bur. Chem. Soils Rpt., 1935, pp. 27-29. Progress results are briefly presented of investigations on dust explosions and farm fires and their prevention. *(Continued on page 316)*

Agricultural Engineering Digest

(Continued from page 312)

AN ELECTRIC HEATER FOR THE MILKING ROOM OF THE PEN TYPE DAIRY BARN, *O. E. Robey.* Michigan Sta. Quart. Bul., 18 (1935), no. 2, pp. 117-120, figs. 3. This equipment is described and its essential features illustrated. The heater is enclosed in a U-shaped pipe made of galvanized iron. An electric fan draws in the cold air at the bottom and blows it through the electric heaters at the middle of the pipe. The warm air is then delivered near the ceiling from the upper end of the pipe. On the outside of the pipe at its center the control device is located. The control mechanism consists of an electric clock and the necessary relays. Ten 650-watt heaters were used to heat the air. These were connected in five pairs, each two heaters being connected in series across a 220-volt line.

Tests of the heater indicated that it would deliver 200 cubic feet of air per minute with a temperature rise of 63 degrees (Fahrenheit). Theoretically, this should heat air in the room through a 40-degree temperature rise in about 15 minutes, with no radiation through the walls of the building. In practice, it took about 0.5 hour to accomplish this result.

The heater has satisfactorily eliminated the condensation problem, and has provided comfortable conditions at milking time.

DRAINAGE OF LAND OVERLYING AN ARTESIAN GROUNDWATER RESERVOIR, *O. W. Israelsen* and *W. W. McLaughlin.* Utah Sta. Bul. 259 (1935), pp. 32, figs. 9. This bulletin constitutes a final report of some phases of drainage studies in Cache Valley, Utah, conducted in cooperation with the USDA Bureau of Agricultural Engineering.

Field measurements of direction of flow of water in soils showed that water flows upward through the compact soils overlying the artesian groundwater reservoir. The piezometric surface was appreciably lowered by the flowing of water from the artesian wells. It was found physically feasible to pump water out of gravel in large enough streams (and also large enough in total volume) to prevent the flow of water upward and further to permit the flow of excess irrigation water and natural precipitation downward through the upper feet of soil as fast as the low permeability of the soil will permit. Measurement of discharge of water from tile drains in lands east of the artesian area did not show any relationship to the pumping of water from the artesian groundwater reservoir. The higher elevation of the piezometric surface in 1932 is believed to be largely due to the increases in precipitation and stream flow, and the accompanying increases in the amounts of water percolating naturally from the mountains and the higher irrigated lands into the artesian groundwater reservoir.

The conclusion is drawn that extensive pumping of water from the artesian groundwater reservoir for a number of years will tend gradually to lower the water table to depths which will prevent further alkali accumulation, permit leaching out the alkali now in the surface soil, and thus gradually improve the soil and increase its productive capacity.

Pumping during only one working day caused a marked lowering of the piezometric surface at six observation wells, one of which was nearly three-fourths of a mile from the pump. The time rate of lowering decreased as the time after starting the pump increased. The piezometric surface rose rapidly after the stopping of the pump, and in one working day it rose almost to its height of the previous day before the pump was started. The time rate of rise decreased consistently as the time after stopping the pump increased. The permeability of the clay surface soil of the waterlogged area was found to be extremely low, whereas the permeability of the artesian groundwater reservoir gravels was found to be relatively high, thus showing that it is much more practical to drain by pumping water out of the gravels than to attempt to draw it out of the clay soils by means of tile drains, without preventing the upward flow from the artesian reservoir.

Tabular data relating to elevations of piezometric surfaces, drain discharges, and water table depths are appended.

THE PEN BARN AND SEPARATE MILKING ROOM, *H. F. McColly* and *J. R. Dice.* North Dakota Sta. Bul. 283 (1935), pp. 26, figs. 22. Technical information is given relating to the planning, design, and construction of the pen barn system for dairy cattle. This system allows the cows to run loose in the barn except when they are being milked. Box stalls are provided for calves, bulls, and cows at calving time or when sick. The cows may be milked in a separate milking room where two or more stalls are provided. They are fed their grain in the milking room at milking time and are usually fed their roughage in the pen from a rack and manger. The milking room is located so that the cows can be herded into one pen and admitted to the milking room, two, three, or four at a time, and after milking are put into another pen. From 25 to 50 per cent more straw is required for pens than for stalls in a standard dairy barn, but usually the cows will keep cleaner than in stanchions. This system is adapted to herds of 10 or more head. If the herd is smaller than this the saving in stall equipment and the other advantages are usually not great enough to warrant not having a stall for each cow.

Details of structural design are presented, including especially those relating to roof trusses and bracing.

FOREST TRUCK TRAIL HANDBOOK. U. S. Dept. Agr., Forest Serv., 1935, pp. [208], figs. 37. The purposes of this handbook are (1) to prescribe standards for the various classes of minor forest highway projects and of both major and minor forest development projects, (2) to outline in sufficient detail the governing factors in the selection of standards so that as far as possible uniform thought and practice may be secured, and (3) to serve as a reference manual on the location, construction, and maintenance of minor projects.

It contains sections on policy, standards, surveys, construction, explosives, maintenance, and cost keeping and concrete.

A large amount of tabular and illustrative material of a technical character is included.

FOREST TRUCK TRAIL HANDBOOK: STRUCTURES SECTION. U. S. Dept. Agr., Forest Serv., 1935, pp. III + 500-548, figs. 62. This section of the 1934 edition of the Forest Truck Trail Handbook gives technical data on bridges, materials, road equipment sheds, powder magazines, portable shops, and cook wagons.

SOIL CONSERVATION AND AGRICULTURAL ENGINEERING INVESTIGATIONS. U. S. Dept. Agr., Sec. Agr. Rpt., 1935, pp. 60-64, 107-109. Types of soil erosion and practical control measures are briefly described, the results of a reconnaissance survey of erosion are presented, and the progress results are presented of investigations on rubber tires for farm machinery, machines for sugar beet production, and farm housing.

WIND EROSION CONTROL AND IRRIGATION INVESTIGATIONS. U. S. Dept. Agr., Bur. Plant Indus. Rpt., 1935, pp. 8, 26, 27. Progress results are briefly presented of investigations on control of wind erosion by proper cultivation, water requirements of crops, subsoil waters, and salinity conditions in soil and irrigation waters, with particular reference to alkali salts and such elements as boron.

EFFECT OF SOIL TEXTURE UPON THE PHYSICAL CHARACTERISTICS OF ADOBE BRICKS, *H. C. Schwalen.* Arizona Sta. Tech. Bul. 58 (1935), pp. 275-294, figs. 7. Studies with several soils and mixtures thereof are reported which showed that the selection of an adobe for building purposes cannot be made solely upon the basis of its strength in compression or flexure and its resistance to washing. Other qualities of much practical importance are the amount and seriousness of shrinkage cracking, the ability to withstand rough handling (toughness), and uniformity of size and shape. For these last-named qualities there are no definite standards for comparison or methods to measure their value.

It was found that a soil similar to a gravelly loam with well graded aggregate is required to produce an adobe of highest quality. Adobes may be made from soils covering a wide range in texture, having a clay content varying between 9 and 28 per cent depending upon the fineness of soil aggregate. In general, adobes made with soils of high clay content shrink greatly with resulting shrinkage cracks. The addition of coarse sand to a fine-grained soil with high clay content is particularly advantageous in reducing shrinkage and increasing the resistance to washing. Adobe muds have a moisture content of from 1 to 5 per cent more than the computed requirements for saturation, varying from 14 to 30 per cent in the adobes tested. Air-dried adobes will have a weight of from 100 to 125 pounds per cubic foot, depending upon how well the soil aggregate is graded. The moisture content of air-dried adobes is very low, varying from less than 1 per cent to almost 8 per cent, and is in general proportional to the clay content.

The average compressive strength of selected adobes made from first-class adobe material may run over 500 pounds per square inch, but a fair value for most selected adobes will be more nearly 400 pounds per square inch. The average for yard-run of adobes will probably be considerably less than the latter figure. The strength of adobes in compression, appears to follow the same law as for concrete in that the greater the density the higher the compressive strength. The transverse strength of adobes is low and it is of importance principally in that it should be sufficient to withstand the rough handling before the adobes are laid in the wall.

The results of the observations and tests which were made further emphasize the fact that adobes have a lower unit strength than other standard building materials. *(Continued on page 320)*

Looking Ahead in Agricultural Engineering

(Continued from page 290)

demand for engineering versatility may be met successfully, or it may be a pitfall.

As scientific development proceeds, there is an increasing tendency to solve problems through the scientific approach. This involves the use of the best knowledge available from men who know. It is the desire, I am sure, of our group to be sought out when engineering problems relating to agriculture are to be solved. This has the challenge in it of being prepared to meet this scientific requirement. The breadth of the field we have to cover and the diversity of the problems to be met, as well as the eagerness of men to seek challenging problems, constitute a real hazard to our profession.

We cannot afford to risk our future with a broadside of training that covers a multitude of subjects and fails to get at the fundamental facts in any of them. Quite the opposite is desirable, and this requires an academic training which is sound in basic theory and above all thorough, even if this has to be acquired at the expense of breadth. There is no place in scientific fields, either pure or applied, for men who do not know, and in our desire to know something of the whole field in which our work lies we are apt to be tempted to neglect the basic principles common to all.

If in our scientific world people who know will be sought, and this must be the case in any scientific approach, then we as engineers should know if we hope to preempt and hold this interesting challenging engineering field we now claim as our own.

A FUTURE OF ENGINEERING ATTAINMENTS IN SERVICE TO AGRICULTURE

To me the professional path ahead seems well defined. It is built upon a thorough and fundamental engineering training with a working knowledge of certain related agricultural subjects. The professional success we attain will depend primarily upon our engineering attainments in service to agriculture. It is too much to assume that the agricultural engineer can attain distinction as an agriculturist as well as an engineer, even though it is possible for him to render a signal service to agriculture through his engineering. I do not desire to belittle in any way the scientific opportunities in agriculture. In fact, what I wish to convey is the thought that agriculture is too complex in its various scientific aspects for the engineer to attain distinction as an agriculturist and still be able to attain eminence as an engineer.

A comment appearing in "Engineering"[6] is significant and worth repeating here: "The complexity and extent of the engineering profession make it impossible for any individual to have a detailed knowledge of more than a relatively small part of the total field."

This comment does not imply a narrow preparation in the basic sciences, but rather the reverse. In my judgment the future agricultural engineer, the same as engineers in other fields, should have a thorough education in the broad principles underlying engineering in all its branches rather than over specialization in any particular direction. He should be well enough informed in the agricultural sciences, however, to have a ready perception of the biological aspects of his engineering work. A knowledge of soils and some understanding of the plant sciences are perhaps most valuable. These, however, should be in addition to the basic engineering subjects rather than at the expense of them.

The agricultural engineer works in an applied science field. To him the application of science is fundamental, and this application must be of a practical working type. Mere theory will not bring satisfaction, or esteem, to the engineer working in this field. *He must be practical.*

I am reminded of an old adage which seems applicable for agricultural engineers: "Be wary of the man who gets his knowledge from books alone for he is like the ass with a load of sandal wood upon his back—he feels the weight, but does not know the value." The successful agricultural engineer of the future, will be well trained fundamentally, and he will supplement his theory with an experience which will bring to fruition the complete resources of his native ability and training.

Moreover, the agricultural engineer to attain the highest esteem should be modest and unassuming, and quite willing to let his associates make appraisals of his work. This, I believe, is wisdom. A biblical reference in this regard seems appropriate: "Let another man praise thee and not thine own words" (Proverbs 27:2).

A STRAIGHT AND NARROW PATH FOR AGRICULTURAL ENGINEERS

I have had a growing feeling for a number of years that our profession, like most new ones, has consumed too much time in proclaiming our importance to society, when we might have made greater progress if we had let others do this for us. However, it is not my purpose to criticize our past, but to look toward the future. In this I fear I may be charged with a rather contradictory and narrow viewpoint. To me our professional future appears brightest if we hold ourselves rather rigidly to the technical and, of course, tangible phases of engineering as related to agriculture. While we should be concerned with social progress the same as any good citizen should be, we invite disaster to good professional service when we try to design social justice into production machinery.

As I view the future, our problem is to narrow our field rather than to expand it, but to broaden our training. The scientific approach requires a thorough and exact knowledge of the foundation principles upon which our profession depends. To be thorough in our field, so it seems to me, requires some narrowing in the scope of our service through more complete cooperation with other fields of engineering and with biological scientists working in agriculture.

The successful agricultural engineer of tomorrow must be a lot better trained than the engineer of today. His basic engineering training must be broader and this should be enriched with practical experience preferably of the trainee or apprentice type previous to responsible practice. There is nothing, so far as I can see, to cloud our vision of a bright professional future when measured in terms of public need and opportunity for service. Professional success, however, will be realized only by capable, well-trained technical men, willing to work for the love of work and who have a high sense of altruistic citizenship. Only such in the future can attain eminence as agricultural engineers.

[6]Engineering (London), vol. 141, no. 3662. March 20, 1936.

Aspects of Land Reclamation in Italy

(Continued from page 296)

wieldy, and sluggish tenures and privileges and create new ones, consistent with rejuvenated lands and enlightened agricultural economy.

No more than a passing reference can be made to the manner in which the vast and costly program of agricultural reclamation has been financed. The guiding principle is this: When it is only a question of improving the soil condition of land already under cultivation, the state comes to the aid of its owner by means of a long-term, low-interest loan and contributes in addition a share of the capital necessary for the work. When, however, the land requires vast preliminary works affecting the interest of large farming districts, draining of marshes, storage, diversion and development of streams, reforestation, roads, etc., these works are considered to be public utilities. The state then designates "comprensori" or districts to benefit by such works, which it effects mostly at its entire expense. This reclamation work, however, is carried only up to the point where it can and must be carried on and completed by the individual owners of the lands affected by the general reclamation, under the penalty of confiscation should they fail to do so. This penalty is designed to prevent the frustration of improvements entailing enormous sacrifices on the part of the state at large.

Perhaps for capitalistic economy, such a practice might be open to criticism, there being apparently no equitable relation between financial outlay and returns. For Italy, however, it has been impossible to condition the furtherance of her most vital activities on a mere bookkeeping basis of credit and debit. The works have been executed in view of the life, growth, and advancement of the Italian people not only today but of the centuries to come.

Integral land reclamation has aimed to foster and encourage the "love of the land" characteristic of Italians of all ages. In reclamation they see now the most solid foundation of their country's new born vigor.

Holding Power of Nails

(Continued from page 295)

In the second series of tests the average figure for the drive screw nails is 366⅔ pounds, although this is not an acceptable figure, inasmuch as weathering split the wood at the points where the nails were driven and their holding power was thereby impaired. Even so, the holding power was far greater than that of the barbed and smooth nails, the increase being 528 per cent and 1052 per cent, respectively.

It is significant that weathering apparently does not decrease the holding power of screw shank nails, although the holding power of barbed and smooth nails is materially decreased by such exposure. The results obtained in the above special tests are in line with certain tests made by the USDA Forest Service, quoted in the following table, covering tests on plain and barbed nails, but none of the screw shank type:

AVERAGE RESULTS OF LOAD-WITHDRAWAL TESTS OF PLAIN AND BARBED NAILS DRIVEN INTO PONDEROSA PINE

(7d nails driven 1¼ inches)

Kind of nail	Green, nailed, and tested at once	Green, nailed, air-dried 42 days and tested	Green, nailed, air-dried 102 days and tested
	(lb)	(lb)	(lb)
Plain	130	23	25
Barbed	101	73	74

Agricultural Engineering Digest

(Continued from page 316)

Explosibility of Agricultural and Other Dusts as Indicated by Maximum Pressure and Rates of Pressure Rise, *P. W. Edwards* and *L. R. Leinbach.* U. S. Dept. Agr., Tech. Bul. 490 (1935), pp. 24, figs. 2. An apparatus and method are described for the determination of the explosibility of dusts. In addition to the maximum pressure developed on explosion, average rate and maximum rate of pressure rise are taken as criteria of explosibility. The explosibility of 133 dusts was determined at two concentrations, 100 to 500 milligrams of dust per liter of air.

To compare the explosibility of dusts, three important factors that enter into an explosive reaction should be taken into consideration, namely, the maximum pressure developed on explosion, the average rate of pressure rise, and the maximum rate of pressure rise.

A study of the structural damage caused by dust explosions has shown that the rate of pressure rise, which may be called the dynamic load, is responsible to a large extent for the damage done. If the rate of rise is sufficiently low, the load on the structure may be released by the blowing out of windows without causing further damage. If the rate of rise is high enough and if the pressure cannot be released sufficiently by windows or other vents, structural damage will occur. For these reasons, the rates of pressure rise, in addition to the maximum pressure, are given as criteria of explosibility.

The ratio of 500-milligram value to 100-milligram value shows the desirability of making explosibility tests at more than one concentration of dust in air. In some cases the values for maximum pressure and average rate or maximum rate of pressure rise at a concentration of 500 milligrams per liter are about half the values obtained at the 100-milligram-per-liter concentration, while with another dust the pressure developed with a 500-milligram-per-liter concentration is 7.5 times that developed at 100 milligrams per liter. Since the tests reported were made at both concentrations, it is believed that they have more significance than those made at one concentration.

Homemade Six-Volt Wind Electric Plants, *H. F. McColly* and *F. Buck.* North Dakota Sta. Circ. 58 (1935), pp. 16, figs. 4. This publication deals with a homemade wind-driven 6-volt battery charger system which may be used to generate energy to keep batteries charged for radios, automobiles, tractor lights, and even small lighting systems for farm houses and other farm buildings where the energy consumption is not large.

The construction and operation of this equipment is described.

Book Received

English in Business and Engineering by *Stevenson, Spicer* and *Ames.* Cloth bound, 365 pages, 6x9 inches, illustrated and indexed. Prentice-Hall, $2.25. The authors provide herein a college text and an engineer's and business man's reference designed to fortify earlier training in composition and to amplify it with instruction on specialized forms. Media of expression considered include problems in writing business letters, research articles, reports, and press releases; and problems in speaking. Mechanical skills in the application of these media are presented as matters of straight thinking and accurate composing. Principles and applications of elementary grammar are conveniently combined in one chapter on "Basic Materials" and presented in form adapted to mature readers. Each chapter includes a list of references for supplementary reading.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

DESIGNER and layout man familiar with the requirements and dimensions of grain and corn harvesting machinery wanted by a leading farm equipment manufacturer. Interesting and profitable future ahead for high-grade man. PO-113